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THE ENERGY, GENDER AND INCOME POVERTY NEXUS:

Energy Consumption Patterns in Urban and Peri-urban Households of Arba-Minch town, Southwestern Ethiopia

BY

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ABSTRACT

The study was conducted in Southwestern Ethiopia with the broad objective of investigating the linkages between energy, gender disparity and income poverty among urban and peri-urban households residing both in and surrounding parts of Arba-Minch town. For the purpose of the study, 658 sample households have been selected from in and around the town of Arba-Minch using random sampling technique and the field data were collected using questionnaires, focus group discussions and key informant interviews. In the field work conducted, data on the consumption of energy sources for this study were gathered in terms of expenditures which were later converted to energy heat values measured in terms of mega joules. The study reveals that commercial fuel become increasingly expensive and the costs of related energy using appliances are beyond the purchasing power of most of urban and peri-urban households. A significant portion of the households continue to suffer as their incomes have not kept pace with the rising prices. Thus, meeting the energy requirements in sustainable manner continues to be a major challenge.

Regression analysis was performed using cross-sectional data to identify major determinants of household end-use energy consumption. The regression analysis revealed that the household income as the most important factor determining household consumption of end-use energy but, other socioeconomic characteristics were also found to have a considerable effect on households' fuel preferences. The study examines the relevance of the energy ladder and fuel stacking models and the findings of this research provide insights for slow energy transition prospect in household energy use. Most urban and peri-urban households cannot easily make a transition from biomass to electricity for cooking end-use since the high costs are major constraints for them. The majority households often lack the ability to optimize their consumption through improved technologies. It is becoming increasingly difficult for most people to obtain affordable energy technologies that convert energy to useful services.Therefore, for the majority of urban and peri-urban households, meeting the energy requirement in a sustainable manner continues to be a major challenge. Increasing end-use efficiency should be given greater emphasis as an important prerequisite and cost effective solution to tackle household level energy problem. It is important to change households' cooking practices by employing proper end-use technologies so that the pressure on surrounding forests could be alleviated and household energy-related problems tackled.

Keywords: Gross and End-use energy consumption; Gender; Income poverty; Energy poverty; Fuel switching and stacking; Arba-Minch town; Southwestern Ethiopia.

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ABBREVATIONS/ACRONYMS

AfDB: African development bank

CSA: Central Statistics Authority

DFID: Department for International Development (UK)

EEPCO Ethiopian Electric Power Corporation

EEU: Ethiopian Electric Utility

ESCAP: Economic and Social Commission for Asia and the Pacific

ESMAP: Energy Sector Management Assistance Program

ETB: Ethiopian Birr

FAO: Food and Agriculture Organization of the United Nations

FDRE: Federal democratic republic of Ethiopia

FfE : Forum for Environment

FHH: Female Headed Household

FGD: Focus Group Discussion

GIZ-: Gesellschaft für Internationale Zusammenarbeit (German International Cooperation)

GTP: Growth and Transformation Plan

IEA: International Energy Agency

IFAD: International Fund for Agricultural Development

Kg : Kilogram

KWh: Kilo Watt hour

lt: Liter

LPG: Liquefied Petroleum Gas

MDG: Millennium Development Goal

MHH: Male-headed household

MoFED: Ministry of Finance and Economic Development

MJ: Mega Joule (10^6 Joule or 1 million joules)

MoWE : Ministry of Water and Energy

MW: Megawatt

NGO: Non-Governmental Organization

OECD: Organization for Economic Co-operation and Development

SNNPR: Southern Nations, Nationalities and People's Region

SPSS: Statistical Package for Social Science

TERI: The Energy and Resources Institute

UNCHS: United Nations Commission for Human Settlement

UNDP: United Nations Development Program

UNFCCC: United Nations Framework Convention on Climate Change

USD: United States Dollar

WEC: World Energy Council

WEO: World Energy Outlook

WHO: World Health Organization

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the study

Energy has a decisive role in our daily life, agriculture, industry and social services (IEA 2007), and it is one of the most essential inputs for sustaining people's livelihoods (Clancy, J., Skutsch, M., and Batchelor, S. 2003).

Energy plays a critical role in a country's development and helps to improve the socio-economic conditions of the people (Adusie 2012). In a study conducted by UNDP (2009), it was shown that no country has substantially reduced poverty in modern times without massively increasing the use of energy. Most development objectives, including the Millennium Development Goals, cannot be met without a universal access to modern energy services.

Access to modern, sustainable, affordable, and reliable energy services is central to addressing many of today's global development challenges. Improving households' access to energy and ensuring regular supply is considered central not only to achieve the MDGs (Adusei 2012) but also to improve the quality of life and sustain the socio-economic conditions of the people (Khandker, S., Barnes, D., and Samad, H. 2010). This view is supported by Barnes et al (2010), TERI (2010) and World Bank (2011) who suggested that access to energy, especially modern sources, is a key to any development initiative and important for almost all aspects of human welfare, including access to water, agricultural productivity, health care, education, job creation, and environmental sustainability.

However, surveys such as that conducted by Cecelski (2004) and UNDP (2009) asserted that, despite many efforts, more people across the world are now subject to energy poverty or energy deficiency and gender inequality exits at every level of the energy sector.In an investigation into energy poverty, IEA (2009) found nearly one-third of human beings in the world lack access to modern energy sources for their very basic activities of life; around 1.6 billion people do not have access to electricity. In another major study, UNDP (2009) found that about 1.6 million people die each year from the adverse effects of indoor air pollution caused by burning of biomass fuels.

As noted by IEA (2010) the total number of people relying on biomass fuels will increase from today's 2.4 billion to 2.7 billion by 2030 due to rapid population growth and urbanization. According to the World Bank (2011), an additional 700 million people need to have access to modern energy services by 2015 if the UN's millennium development poverty alleviation goal is to be met. Sarkar (2005) holds the view that people without modern energy services must spend more of their time and physical energy on survival and, therefore, have fewer opportunities to pursue educational and income-generating activities. Similarly, WHO (2011) found that lack of access to convenient and efficient energy services is a major barrier to achieving meaningful and long-lasting solutions to poverty.

In this regard IEA (2009) pointed out that the welfare of around 2.5 billion people worldwide is continuously challenged by the dependence on inefficient biomass fuels for their daily cooking energy needs. According to WHO (2011) indoor air pollution results in 1.6 million deaths worldwide each year, 85 percent are women and children who die from cancer, acute respiratory infections and lung disease. In a study conducted by Meikle and North (2005), it was shown that the main reasons for the heavy reliance on traditional fuels for urban energy needs are low income levels, limited energy infrastructure; and erratic supplies of modern fuels.

In many sub-Saharan Africa countries, over 80 percent of the population depends mainly on solid biomass in order to meet their basic needs for cooking and lighting (UNDP 2009). The absence of modern sources of energy at reasonable prices is a serious poverty trap in the region (AfDB 2014). As stated by IEA (2009), the heavy reliance on biomass energy and slow growth in conventional energy use in sub-Saharan Africa is unlikely to change in the near future, given the stagnant (or sometimes declining) per capita national incomes.

Like many other sub-Saharan Africa countries, Ethiopia depends heavily on traditional energy sources with minimal production and use of modern sources (Zenebe 2007). A report by MoWE (2011) reveals that 92 percent of Ethiopia's energy demand is met from biomass source. Nebiyu (2009) reported that the country is having difficulty in meeting the rapidly rising demand for modern energy.

Ethiopia is believed to be potentially well endowed with a variety of clean energy sources, such as hydropower, geothermal, wind, and solar energy, however, much of the potential energy resources are not yet exploited (Dawit 2012). Ethiopia has an enormous potential for clean energy developments with the generating capacity of about 45,000 MW from hydro; more than 3,000 MW from geothermal; and over 10,000 MW from wind and solar energy sources (Dereje 2013). Nevertheless, the country now has an installed generation capacity of only 2,268 MW from hydro, wind, geothermal and thermal energy sources. Every year more than 700 MW of new power demand is created due to the flourishing manufacturing sector. The electric power demand is increasing at a rate of 32 percent every year (MoWE 2011).

The Ethiopian power sector is small even in African standards and per capita power consumption is significantly lower than many African countries (World Bank 2011). Currently 52 percent of the population is said to have access to electricity and the electric energy consumption per capita is estimated to be 77 kWh, which is one of the lowest consumption rate even among the least developing countries (Dereje 2013). EEU, which functions under MoWE as the national power utility, indicated that 70 percent of the housing units in urban areas of the country used electricity as the main source of lighting in 2000 which increased to 75.3 percent in 2004 and 88.0 percent in 2011, but the use of electricity for cooking is limited to very few households in the larger towns. Yet over 63.3 percent of the households use firewood as the main source of fuel for cooking in urban areas of the country.

The world's urban poor are worse off than their rural relatives (UN-HABITAT 2012). Karekezi and Kithyoma (2005) in their study found that rapid urban and peri-urban population growth rate has been accompanied by higher levels of urban and peri-urban poverty. Within the urban population in Kenya, about 49 percent are considered poor and live below the poverty line.

Urban population is growing rapidly in Ethiopia. MoFED (2008) estimated that urban population growth at the rate of 4.1percent per annum. Tegegn (2010) noted that the country's urban poverty, in comparison to rural poverty and national level poverty, has increased over time.

High incidences of poverty have been reported among FHHs all over the world (FAO 2008). FHHs have much lower income levels and are more likely associated with poverty compared to those headed by men (Clancy 2006). Women are disadvantaged when compared to men in virtually all aspects of life because of the gender differences pertinent in the society. Many of them were found to be relying on low paying and insecure income source such as daily labor and other informal activities mainly petty trades to make their living (Emebet 2008). Ramakrishnan (2009) further stated that in most developing countries FHHs are viewed as being at greater economic disadvantage than MHHs because they appear to have less income earning capacity than their male counterparts.

Researches carried out in Ethiopia (such as Emebet 2008; Berhanu 2011and MoFED 2011) reveal that there are higher proportions of poor FHHs than MHHs in urban areas. They argued that FHHs are characterized by low and insecure income as most of them are engaged in informal activities and hence are poorer than their counterparts. Furthermore, a report by the MoFED (2011) has indicated that there has been a significant increase in the percentage of FHHs in recent years. The report further shows that the incidence of FHHs under absolute poverty is very likely to grow higher than the MHHs in urban Ethiopia and they are amongst the most vulnerable groups to energy related problems.

In the study of the incidence of poverty (Meron 2005; Emebet 2008 and Berhanu 2011), it was shown that women predominate the urban poor because the jobs women obtain are poorly paid, part time or insecure. Women are subject to discrimination in labor, credit and a variety of other markets and they own less property compared to men.

Many of the FHHs were found to be relying on low paying and insecure income source such as daily labor and other informal activities mainly petty trades to make their living.

Overall, the extent of the problem to FHHs compared to their male counterparts, imply that these households should be given due attention in the effort of poverty alleviation. As women are often held responsible for arrangement and usage of energy fuels, it is important that special attention be given to women while addressing energy poverty. Nonetheless, according to Clancy (2000), the energy sector has been very slow, compared to other sectors, to mainstream gender into their policies and practices.

The risk of poverty is greater for women and they are at the receiving ends of energy poverty because of their low social and economic status (Cecelski 2000). The urban poor, particularly the women, are more vulnerable to the negative impact of energy poverty and suffer disproportionately from the impacts of scarcity of fuels, air pollution and environmental degradation (Clancy *et al*. 2003).

In sub-Saharan African countries, FHHs are more likely to be poor and thus less able to afford the up-front cost of new stoves or electricity connections (Köhlin, G., Sils, E., Pattanayak S., and Wilfong, C. 2011). A study by Nkomo (2007), for instance, has indicated that approximately 41percent of the households in South Africa are FHHs which are very likely to be extremely poor and rely heavily on biomass. Clancy (2006), in a detailed household survey in three cities of Tanzania, found that FHHs use a higher average percentage of their income than MHHs for purchasing energy. The implication of such a finding is that FHHs will suffer more than MHHs from rapid energy price rises.

Overall, there seems to be some evidence to indicate that energy poverty has serious implications on gender disparity at the household level. Considering all of this evidence, it seems that, energy issues must get more attention than ever before by policy makers as a significant factor in achieving sustainable livelihoods.

The link between gender issues and sustainable energy development has been discussed extensively in the literature (such as Clancy 2000; Reddy 2004; Heltberg 2004 and Cecelski2004) however, they have focused mainly on the rural-side and little has been done with respect to urban dimension of the problem. These studies have considered issues for linking the household energy and health issues and economic status with rural women and fail to recognize how women and low income households from urban areas are at the receiving ends of energy poverty. Whilst there is a significant body of knowledge on how energy affects the rural women, energy is critical in the daily lives of not only rural women, but also women in the urban areas of developing countries. As Nussbaumer,P., Bazallian,M., Modi,V. and Yumkella,K.(2011) pointed out energy is critical in the daily lives of women, both in the rural areas, and in the urban areas, thus gender analysis in energy has gained prominence because of the ever-increasing attention being given to energy issues.

The findings of this paper could be used to help, from the viewpoint of supporting gender equity and gender empowerment through energy solutions. It is evident that men still make most of the critical decisions regarding the type of fuels and energy end-use equipment to be used in most households. Men will often decide on the stove technology if it is to be purchased. According to Adousei (2012) men are becoming involved in decision making regarding what type of energy should be used in the house and how the energy is brought to the house to be used.

Cecelski (2004) and Clancy (2006) and Ramakrishnan (2009).noted although energy provision is seen as the women's responsibility, decisions related to purchase including stoves are still made by men who determine household priorities while women's access to decision-making within the household and community is restricted due to their traditional roles, household responsibilities, and low social, economic and political status

However, female heads are not restricted. They often held responsible for ensuring constant supply of energy in the households and are directly involved in decision making regarding what type of energy should be used in the house. Nonetheless Information from a number of countries worldwide shows that there has been a significant increase in the number of FHHs that have a harder time escaping poverty than MHHs (IFAD 2006).

Nowadays, according to Clancy et *al*. (2003); Khandker *et al. (*2010); TERI (2010); and Getamesay, B., Workneh N., and Getachew, E.,(2015) the existence of energy poverty is quite well accepted around the world and it is growing significantly in developing countries. TERI (2010) further indicated that the income poor face high burden of energy poverty as they tend to spend a larger share of their income on purchasing inefficient and harmful energy fuels. According to Khandker *et al. (*2010) this problem is acute among the poor households as people with less income have limited access to clean fuels.

Cognizant of the energy poverty, the government of Ethiopia has been spending huge sum of money to increase hydroelectric power generating stations and is strongly committed to extending the availability of modern energy in order to facilitate an accelerated national socio-economic development. The Ethiopian government plans to construct several new generating facilities to provide electricity at different parts of the country and to export power to neighboring countries (Kenya, Sudan and Djibouti) (EEPCo 2011).

1.2. Statement of the problem

According to Arba-Minch Town Administration Office (2014), the study area, Arba-Minch town and its surroundings, is one of the recently growing urban areas of the country which has been attracting people from the nearby rural areas. The expansion of the town to the periphery has intensified the transformation of rural settlement into urban land. The rate of energy demand increase appears to be outpacing the rate at which energy supply is being increased. The rising demand for commercially traded biomass fuels shows a growing pressure on local riverine and woodland forests to meet cooking demands of the urban households. The high and direct dependence on biomass fuels mainly for baking and cooking purposes are contributing to unnecessary high level of forest resource removal which has resulted in growing shortage of biomass fuels and higher wood fuels prices.

In spite of the high levels of poverty, the ongoing rapid urbanization in developing countries is expected to result in the growing demand for energy resources (Karekezi and Kithyoma 2005). At present despite the level of access to clean fuels has shown an improvement in last few years in the study area, a large number of urban households still face limited, inefficient and expensive energy options to meet for cooking and lighting needs. In spite of the improvement of level of access to clean fuels in the last few years, most urban and peri-urban households in the study area still appear not to be benefiting significantly from improved modern fuel supply availability. An irregular supply of electricity undoubtedly creates huge inconvenience for its users and its use for baking and cooking is limited to very few households. There are sudden and frequent blackouts and voltage drops which can make electricity a very unreliable source of energy for use domestically and the users find it hard to predict its availability.

To date, a number of studies (such as Reddy 2004; Nkomo 2007 and GIZ 2008) have shown that reliable and affordable energy remains an essential prerequisite for combating poverty. Considering all of this evidence, it seems that the energy-poverty nexus exists at the household levels, where they use disproportionately more biomass fuels. Still most urban households in the study area are the principal consumers of biomass fuel because they have limited access to such alternative fuels as kerosene and LPG. This hinders their efforts to move out of poverty and seriously constrains their ability to improve their living situations.

Moreover, prices for commercial cooking fuels are already very high in the market for the majority of urban households. A substantial portion of the urban households continue to suffer as their incomes have not kept pace with the rising prices and face higher financial burden to meet their cooking demands. Therefore, meeting the energy requirements in sustainable manner continues to be a major challenge. Thus, the livelihood of the urban households will continue to be critically impaired by energy poverty, that will seriously slow down their wellbeing and the ultimate result will certainly affect the development of the study area.

Up to now, several studies (Alam *et al.* 1998;Samuel 2002; Reddy 2004; Heltberg 2004; Barnes *et al* 2004; Farsei *et al.* 2005; Barnes and Toman 2006; and Araya and Yissehak 2012) have demonstrated the phenomenon of an energy switching that explain as the household income increases, modern fuels will phase out wood fuels. These writers consistently indicate a strong correlation between household income levels and the types and amounts of fuel used for cooking.

Reddy (2004) has confirmed the hypothesis that households ascend an energy ladder and the choice is largely determined by income among households residing in the cities of developing countries. Alam, M., Sathaye, J., and Barnes, D.(1998) concluded that biomass based fuels are being steadily replaced by modern fossil fuels and electricity as source of household energy, and urban households shift from using biomass, to modern fuels for cooking purposes. According to Farsi, M., Filippini, M., and Pachauri, S. (2005) there appears to be a clear order of preference and progression in terms of the switching and substitution behavior of households in their choice of cooking fuel. TERI (2010) suggests he energy ladder has the traditional sources of energy on its lowest rung and kerosene in next rung, while LPG is present in the highest rung.

It appears to imply that a move up to a new fuel is simultaneously a move away from previously used fuels (Heltberg 2005 cited in Alemu *et al.* 2009).Barnes; D., Krutilla, K., and Hyde, W. (2004) hold the view that changes in energy-use patterns usually take the form of a gradual decline of biomass fuels. As income increases, we would expect that households would substitute to higher quality fuel choices and there is a decline in the percentage of consumers who chose to consume biomass fuels. Bereket K., Almaz B., and Elias K.(2002) and Samuel (2002) confirm the general validity of the 'energy ladder' hypothesis and they argued that the energy transition hypothesis is confirmed in urban Ethiopia by revealing that the probability of consuming traditional fuels in general declines with increase in income.

The energy ladder hypothesis prescribes income to be the sole factor. As incomes increase, there is a decline in the percentage of consumers who chose to consume traditional fuels, as well as the transitional fuel kerosene, and an increase in the percentage of consumers who consume LPG and electricity (Barnes *et al.* 2004). Results of the study confirm the hypothesis that households ascend an energy ladder and the choice is largely determined by income in fuel selection amongst households in Bangalore (Farsei *et al.* 2005).

Overall, these writers argued that income of the households to be the sole factor in the selection of a fuel and the movement towards other alternatives; and they further demonstrated that urban households are looking the wood fuels as inferior fuels for the reason that wood fuels do not fit well into the urban lifestyle. As the household income rises, not only household tends to shift from biomass fuels to modern fuels but also the introduction of modern fuels will phase out biomass fuels.

Others (see Massera *et al*. 2000; Bereket 200; Alemu and Kholin 2008; Kammen and Kirubi 2009; Abebe and Koch 2011; and Yonas *et al*. 2013) more concerned with fuel stacking hypothesis. These writers evaluate and criticize energy switching hypothesis as it fails appropriately to account for other factors that are likely to affect household switches to modern energy services.

More recently, it has been argued that households in developing countries do not switch to modern energy sources but instead tend to consume a combination of fuels. This means households choose different fuels as from a menu, rather than completely switching from one form or fuel to another. This method of fuel usage is known as fuel stacking as opposed to fuel switching or an energy ladder (Masera*et al*. 2000; Heltberg 2005 cited in Alemu *et al*. 2009).

According to Masera, O., Saatkamp, B., and Kammen, D. (2000) the issue of fuel stacking behavior (the use of multiple fuels) has not been carefully examined, especially in Africa. Likewise, according to Alemu, M., Zenebe, G., Menale, K., and Kolin, G. (2009) while previous studies that looked into fuel stacking used data mainly from rural areas in Latin America and Asia, they suggest that more studies be conducted to examine these issues to find out how important they are for towns in sub-Saharan Africa.

This study challenges such widely held view of this switching hypothesis and contributes additional evidence that suggests wood fuels are not perceived as inferior rather they are popular regardless of household's economic status. The contribution of this study therefore, has been to test the relevance or application of the concept of fuel switching to the study area. The findings of this investigation complement those of earlier studies (Massera *et al*. 2000;Kammen and Kirubi 2009; Alemu and Kohlin 2008, and Abebe and Koch 2011) who pointed out households generally used more fuel types as their incomes increased, instead of (completely) switching to another fuel type. High income levels alone may not be a sufficient determinant of fuel switching. Currently, despite a rise in price, wood fuels are still the choice of most households for baking and cooking purposes regardless of household's economic status. The use of modern fuels such as electricity, kerosene and biogas is generally accompanied by biomass fuel rather than completely substituting one another for baking and cooking applications. The majority of households achieve fuel transition as far as lighting is concerned.

Most studies have focused on the major cities of the country. However, So far, there have been no adequate surveys to test the relevance of fuel stacking in the smaller and medium towns of the country like Arba-Minch. Thus, the contribution of this study has been to confirm the relevance of the concept of fuel stacking to urban and peri-urban households by exploring how household end-use energy consumption is related to the socio-economic and demographic characteristics of households at the local level. The findings of this study have a number of practical implications because the study suggests the need to focus on other factors besides household income in policy design. The study argues that policy makers could target these variables to encourage transition to cleaner energy sources.

Most international seminal works (such as Clancy *et al.* 2003; Heltberg 2004; Cecelski 2004; Nijenga and Clancy 2005; and Wickramasinghe 2007) have noted that FHHs are restricted in making most of the critical decisions regarding the type of fuels and energy end-use equipment to be used in the household, thus FHHs generally can be expected to be living in extreme energy poverty.

However, the present study contributes additional evidence that suggests with increasing incomes, female heads are directly involved in decision making and can decide by themselves regarding what type of energy should be used in the house. While FHHs may face greater difficulties than men in gaining access to socio-economic services, they may be better off in some ways. FHHs often held responsible for ensuring constant supply of energy in the households and are directly involved in decision making regarding what type of energy should be used in the house. Thus, when they are bread winners and prime decision makers of a household, switching to modern baking and cooking appliances appears to be faster with increasing their incomes compared to that of their counterparts. Even if they are limited to be in a better economic status, the control of cash income allows them to purchase independently some items like kitchen appliances that would increase the productivity of their cooking time.

Within the country, studies (such as Samuel 2002; Alemu and Köhlin 2008; Zenebe *et al.* 2010; Abebe, and Koch 2011; Araya and Yissehak 2012; Dereje 2013; Yonas *et al.* 2013; and Getamesay *et al.* 2015)in the field of energy are focusing at either national level or regional capitals, and directed towards hydropower (electrical energy generation) contribution as a major supply to the country's energy need. So far, no studies to our knowledge have explored the energy's link with poverty, and gender aspects among urban households in small and medium sized towns of the country.

This study, therefore, focused on urban and peri-urban households of Arba-Minch town, Southwestern Ethiopia with a view of investigating income poverty and gender disparity in the access to and end-use consumption of different energy sources. The present study contributes additional evidence based on micro-level data and focuses on energy at the household level. It also provides further insight into the attitudes and behaviors of household heads regarding their choice of fuels. Results of this study are expected to analyze household energy consumption patterns in order to formulate policies for promotion of sustainable energy consumption.

Although urban energy has recently become one of the major research topics attracting the attention of many researchers, many previous studies (for instance, ESMAP 2006; Nebiyou 2009; Shanko *et al.* 2009; TERI 2010; DFID 2011 and Dawit 2012) emphasized the rural side and little research looked at the urban dimension. They demonstrated that the rural population serves as the proxy for the poor due to its relative lower economic status compared to its urban counterpart.

Nevertheless, the world's urban poor are worse off than their rural relatives (UN-HABITAT 2012). As expected, urban energy consumption is growing rapidly, driven by the fast growth of urban centers. Karekezi, S., Mapako, M., &Teferra M. (2002) in their study found that although the supply of modern energy resources in urban areas being far much better than in rural areas, access to modern energy among urban households is still inadequate. Likewise, Karekezi, S. and Kithyoma, J. (2005) ascertained that there are inequity issues in urban energy markets that put low income consumers at a serious disadvantage. Low-income households in urban and peri-urban areas also suffer from lack of access to energy services, and their numbers are likely to increase.

As Zenebe (2007) noted research needs to take a broad rural-urban approach to the fuel problem, as rurally conceived and rurally focused solutions will be insufficient. Although energy in general and urban energy in particular has recently become one of the major research topics attracting the attention of many researchers and research institutions, there is still clear shortage in gender disaggregate data on urban energy use. Thus, the key rationale for focusing on the urban and peri-urban areas in this study is that, this time urban dwellers generally face higher living costs than their counterparts and, their situation is different to rural areas since there is a greater reliance on purchased fuels.

1.3. Aims and Objectives

This study aims to investigate the linkages between income poverty and gender disparity in the consumption of gross and end-use energy among urban and peri-urban households in Arba-Minch town, Southwestern Ethiopia. More specifically, the study has targeted the following objectives:

- To assessgender disparity on the utilization of gross and end-use energy among households residing in the town and its surroundings;
- To examine urban and peri-urban households' gross and end-use energy consumption patterns at different income category;
- To explore a variety of biomass and conventional energy sources for the basic areas of end-use energy services (cooking and lighting) to the households residing in urban and peri-urban areas;

- To identify reasons and determining factors that may explain the consumption of end-use energy among households in and around the town;
- To assess the challenges and the coping mechanisms with current use of energy among urban and peri-urban households.

1.4. Research Questions

On the basis of the above research objectives, this study strives to provide answers to the following key research questions:

- What is the gross and end-use energy consumption pattern at different income category of urban and peri-urban households?
- What are the experiences of MHHs and FHHs towards managing and using various energy sources?
- What are the positions of biomass and conventional energy sources in the overall gross and end-use energy consumptions?
- What are the influencing factors for the consumption of end-use energy among households in and around the town?
- What are the challenges and the coping mechanisms with current use of energy among urban and peri-urban households?

1.5. Hypotheses

The research has been based on the hypothesis that the utilization of household end-use energy is a function of income of the household, household size, gender, age, occupation, education level of the household head, marital status, cost and performance of end-use technology being used, ownership of housing unit and characteristics of quality of housing unit thus it is hypothesized that using more end-use energy is influenced by the aforementioned factors. This paper seeks to address the following hypotheses:

- ✓ Household end-use energy consumption is positively influenced by household income, education, occupation of the household heads, modern end-use energy equipment, house ownership, private electric meters, good qualities of housing units and kitchens. With increasing these factors, the probability of consuming end-use energy is expected to increase.

- ✓ On the other hand, the reverse is true to the factors such as age, family size and traditional end-use energy equipment which are negatively related with the consumption of end-use energy. An increase in the units of these factors means, lower tendency to consume end-use energy

1.6. Significance of the study

Since this research is focused on the study of end-use energy consumption pattern among urban and peri-urban households, the findings should make an important contribution of knowledge to the field of energy. This study provides an opportunity to advance knowledge of income and gender disparity in the consumption of end-use energy. It provides a clear understanding, based on micro-level gender disaggregated data, of the issues around urban energy consumption.

The current findings add to a growing body of literature on gender specific urban energy use. The study offers some important insights into how household end-use energy consumption is related to the socio-economic and demographic characteristics of households at the local level. The findings of this study would also serve as an input for development practitioners and policy makers in formulating effective policies, strategies, development programs and projects in order to alleviate urban energy poverty and enhancing the living condition of urban households by ensuring effective utilization of energy resources among households in the urban and peri- urban areas.

The focus of the study is directed towards how to enable households to get out of the energy-poverty trap. This is an important issue that requires far more attention from policy makers in order to alleviate poverty. the study has been anticipated to contribute for development practitioners that are interested in alleviating energy poverty Therefore, this study will contribute significantly to the development of such important issues and will serve as a basis for decision-making in the social policy aspects of energy poverty by indicating the important determinant factors in the consumption of end-use energy that need special attention. Besides, focusing on these factors at household level would be of help to understand the problems deeply and to formulate methods in order to effectively utilize the available energy resources.

1.7. Scope of the study

The study was conducted in and around the town of Arba-Minch with the broad objective of investigating the linkage between income poverty and the domestic end-use energy consumption pattern among MHHs and FHHs at the household level. It is beyond the scope of this study to examine rural dwellers. For the purposes of this paper, energy is taken to include fuels such as biomass (firewood, charcoal, sawdust, dung) and conventional (electricity, kerosene, biogas) sources. The study is based on most frequented types of energy end-uses such as cooking and lighting.

Since urban life is a function of monetized economy, household income plays a direct and great effect on urban poverty (Mekonnen 1999) and there is some evidence to suggest that as there is a vicious circle between energy poverty and income poverty, it is important that the measures taken to address energy poverty should take into consideration the income level of the households (TERI 2010). An implication of this is the possibility that study considers average household income as proxy indicator of poverty.

1.8.Research Limitations

At the time of the interview, the situations like fear, suspicion and mistrust have restrained respondents from giving correct responses on questions particularly related to income and working conditions, and few respondents were not willing to tell correct information about their current monthly or annual income. There were also more people without defined salaries and the incomes they got were from miscellaneous activities. So it was difficult to obtain accurate estimates of monthly income of the household. The household major expenditure has been taken as a proxy to estimate the household income. Furthermore, it was also difficult to find some household heads in person since they were busy with their daily works. Some respondents found it difficult to take time off their business transactions as they viewed the survey would take up too much of their valuable time.

1.9. Organization of the study

The study is organized under nine chapters. The first chapter discusses the introduction part focusing mainly on the background of the study, statement of the problem, aim and objectives, basic research questions, hypotheses, significance of the study, scope of the study, limitations of the study and organization of the study. The second chapter focuses on the review of literature that includes both the conceptual and related literature. The major components of the chapter comprise analytical concepts, empirical findings, and theoretical approaches to the study.

Chapter three describes the methodology of the study. Under this chapter, the study area, research design, data collection methods, sampling techniques and methods of data analysis are explained. Chapter four discusses the energy-consumption patterns among the urban and peri-urban households. Here, the positions of biomass and conventional fuels in the overall gross and end-use household energy utilization are considered. Chapter five examines gender disparities in the consumption of household end-use energy. The chapter also examines overall perceptions and experiences of the urban MHHs and FHHs towards different energy sources. Chapter six focuses on the linkage between energy and income poverty. The consumption patterns of end use energy at different economic strata group is dealt here. Chapter seven addresses household preferences towards sources of energy. Here, the demographic and socio-economic determinants of household end-use energy consumption in the town and surroundings are analyzed. Chapter eight discusses major energy use related challenges and coping mechanisms among households residing in urban and peri-urban areas. Finally, based on the results of the empirical analysis, conclusion and recommendations of the study are presented. At the end, issues for further research in related areas are also highlighted.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Related Literature

Energy in itself has never been accepted as a basic human need like water and food rather it is the means to an end to the provision of basic needs (UNDP 2009). Energy, although not an end in itself, remains an essential tool to facilitate socio-economic activities and promote human empowerment (Bereket 2001). Similarly, ESMAP (2006) found that the mainstreaming of renewable energy is not an end in itself, but it is a means to reduce poverty and global environmental damage that results from energy use. In another major study conducted by DFID (2011), it was shown that what human being want is the services that those energy sources provide. People do not want energy in itself but the energy service that provides cooking, lighting, heating, water pumping, transport, etc.

This view is supported by Sarker (2005), Wadjamsse (2008) and Kahndker *et al.* (2010) who wrote that energy is a necessary, but not a sufficient condition for economic and social development. Although the access to clean sources of energy is not a sufficient condition for poverty alleviation, it constitutes absolutely a necessary condition. Likewise, in a study conducted by Adusei (2012), it was shown that energy is a critical resource necessary for improving the living conditions of the people and for maintaining economic growth and development.

Moreover, TERI (2010) and Khandker *et al.* (2010) revealed the important role of energy services in almost all aspects of human welfare. At a local level, energy services help improve the quality of life and facilitate sustainable livelihoods. Barnes *et al.* (2010) argue energy per se is absolutely essential for meeting basic human needs, and is central to the everyday lives of people. At a national level, as Aduosi (2012) points out energy plays a critical role and helps to facilitate stable economic development, attract foreign direct investment, allow access to global markets, have an impact on the national and global environment and can affect national budget allocations.

Countries with high levels of economic growth also used high levels of energy. Countries that can afford to consume great amounts of modern energy continue to expand their economies. For instance, for each person in the United States energy consumption is 10 times the amount that is used in India (Khandker *et al.*2010). According to Ntobeg (2007) and WEO (2010) no meaningful national development planning is conceivable without the contributions of the energy sector. None of the Millennium Development Goals can be met without major improvement in the quality and quantity of energy services.

Overall, these studies show that the importance of energy in our daily lives derives simply from the fact that it provides essential human services. It has commonly been assumed that energy, although not an end in itself remains an essential tool to achieve sustainable development and overall improvement in the quality of life. It is evident that energy in general, clean, efficient, affordable and reliable energy services in particular are essential to achieve overall improvement in the quality of life. Without access to efficient and affordable energy sources, people have very limited opportunities for economic and social advancement and their ability to earn a living is also severely affected.

In the subsequent sections the concepts of energy and related categories, characteristics of domestic energy consumption, urban domestic energy use and gender disparities, urban domestic energy use and equity problem, and overall domestic energy use patterns in Ethiopia will be discussed in detail.

2.1.1. Concepts of Energy and Related Categories

Energy, the capacity to do work or the stored ability to perform work, exists in a number of different forms such as chemical energy, electrical energy, heat (thermal) energy, light (radiant) energy, mechanical energy, and nuclear energy (UNDP 2009). Energy can be extracted from various sources which are categorized as primary and secondary sources. OECD (2010) uses the term 'primary source of energy' to refer to the energy available in any fuel before it is converted to a delivered energy. It is any energy that exists naturally and has not been modified into another form by human beings. Reddy (2004) holds the view that primary energy resources are processed in a power plant or other facility and are transformed into carriers or secondary energy sources such as electricity.

As Karekezi and Kithyoma (2005) indicated, examples of primary energy resources include both renewable energy resources, such as biomass, hydroelectric power, wind and solar energy, and non-renewable energy resources like fossil fuels.

The renewable energy resources are generally more sustainable than non-renewable ones as they are continuously replenished and constantly renewed by natural processes. These energy sources are called "renewable" because they cannot be exhausted and be used over and over again without fear of running out (Getis. A, Getis.J, and Fellmann D. 2000). Worldwide the most widely used non renewable energy sources, which are formed from the remains of ancient plant and animal life buried deep in the crust by great pressure applied on over a long period of time, are fossil fuels such as oil, coal, and natural gas. These fuels are referred to as exhaustible energy sources. Once they are used up, they are gone forever and generated so slowly, and they may take a longer period of time to replenish (IEA 2010).

On the other hand, according to a definition provided by Clancy *et al*. (2003) and IEA (2010), the secondary energy source is electricity since it is an outcome of a human-made transformation process. That means we get electricity from the conversion of primary sources, such as coal, natural gas, oil, nuclear, or solar energy. Thus, it is also referred to as an energy carrier from in which energy is delivered to the end-user.

The various types of energy resources used for different purposes can be further classified as traditional and modern ones. The term traditional energy source is used by Karekezi and Kithyoma (2005) to refer to readily available, low cost and unprocessed fuel. For Mekonnen (1999), biomass fuels are synonymous to traditional fuels indicating primary forms and low quality fuels while on the other hand it indicates that the fuel supply and utilization system is fully integrated with the rural way of life. Clancy *et al.* (2003) used the term biomass fuel interchangeably with traditional fuel as biomass fuel is synonymous to 'traditional' fuel. Biomass fuel refers to any organic matter and includes forest residues; agricultural waste; wood and wood waste; animal waste; aquatic plants; and municipal waste (Karekezi, S., Kimani, J., and Onguru, O. 2002). As compared to other energy sources, biomass energy can be used for production of fuel with diverse and wider uses. Karekezi and Kithyoma(2005) examined biomass energy could be directly utilized for basic energy needs (e.g. firewood, charcoal, dung cake, etc.) or transformed into an energy-rich gas called biogas which is produced through the anaerobic degradation of organic matter (from plants or animals) by a consortium of bacteria for household.

For Cecelski (2004), biomass fuels consist of firewood, charcoal, animal wastes and agricultural or crop residues that are relatively inefficient, least convenient to use and hazardous for health. Barnes *et al*. (2004) and Kahndker *et al*. (2010) used clean energy and modern energy interchangeably. They revealed that the liquid fuels, such as kerosene and LPG, along with electricity, are considered as modern forms of energy. According to IEA (2009) the modern energy sources are considered to be those that have a high energy density, high combustion efficiency and high heat-transfer efficiency so that they are less hazardous for health and save time and costs for their users.

There are two quite commonly-used measures of energy use: gross and end-use energy. Clancy *et al*. (2003) uses the term 'gross energy' to refer to the amount of total input of energy that is burned for cooking regardless of the efficiency of the appliances that people use. Whereas the term end-use energy refers to the amount of energy effectively used to perform the task required by the end user (Barnes *et al.* 2004). A further definition is given by Kahndker *et al.* (2010) who describe useful or "delivered" energy as the energy that is adjusted for the efficiency of the appliance, technology and mode of use by the household.

Throughout this paper, the terms input and gross are used interchangeably, and the broad use of the term end-use energy is equated with useful energy. Throughout the study the level of fuel consumption is computed by using the standard energy content of all energy sources in terms of heat value of energy. The term energy efficiency is used by Barnes, D., Khandker, S., and Samad, A. (2010) to refer to a percentage of total energy input to equipment that is consumed in useful work and not wasted as useless heat. According to Clancy *et al*. (2003), energy efficiency can be defined as follows: 'a conversion ratio of output energy and input energy of production technologies and end-use appliances'.

The other frequently used term among energy and development specialists is energy or fuel poverty. Although the terms are widely used in literature, one hardly comes across a clear definition. These concepts have been increasingly debated and loosely defined (Heltberg 2005; IEA 2009; Barnes *et al*. 2010; Boardman 2010; and Getamesay *et al*. 2015). Many writers fail to agree on what exactly is the minimum level of energy poverty line. For instance, Modi and Goldemberg (2005) cited in Getamesay *et al*. (2015) measured energy poverty in terms of physical energy amount. For example, the physical energy requirements, proposed by Goldemberg (1990) cited in Khandker *et al.* (2010), includes a wider range of energy-using activities, placing that estimate at 32.1kilograms of oil equivalent (kgoe) per household per month as the minimum amount, while Modi *et.al.*(2005) cited in Khandker *et al.* (2010) computed 50 kilograms of oil equivalent (kgoe) per household per month for cooking and lighting as energy poverty line. All these works used the minimum amount of energy for estimation of energy poverty line in terms of physical amount without considering economic aspects.

Barnes *et al*. (2010) and Khandker *et al*. (2010) developed an approach that defines an energy poverty line as a threshold of energy consumption needed to sustain life. This approach is tested using household survey data from Bangladesh and India. They used the term energy poverty to refer to the condition of having less than a certain level of daily energy consumption necessary to maintain a minimum standard of living. They argued that simple access to modern energy, such as electricity, does not ensure households are energy non-poor. How much they consume and whether the electricity supply is reliable are also key factors.

While other studies (such as Pachauri and Spreng2004; ESMAP 2006; Boardman 2010; WHO 2011; and ESCAP 2012) estimated energy poverty on the basis of economic or expenditure aspect. Energy poverty is at a level when households' energy expenditure is more than10 percent of the disposable income, excluding other factors. Pachauri and Spreng (2004) have adopted a cutoff point of 10 percent of total expenditure because it is frequently mentioned in the literature as common level of expenditure for poor households. Boardman (2010) noted fuel-poor households are considered to have 'energy costs which are excessive compared to overall household income.

Similarly, WHO(2011) and ESCAP(2012) classified households as energy poor if more than 10 percent of their total monthly household income is devoted to energy expenditure. This is to say that, there is a high correlation between increasing income levels and the adoption of clean energy alternatives by households. Thus when household income rises, then people are more likely to switch to modern substitutes.

Overall, in these studies the idea is that households forced to spend as much as 10 percent of cash income on energy are being deprived of other basic goods and services needed to sustain life. While a variety of definitions of the term energy poverty have been suggested, this paper will describe a household as energy poor if the income it spends on energy exceeds certain percentage of its total income. It defines a household as energy poor if it spends more than 10 percent of its income on energy.

In most western countries, the term fuel poverty is often defined as inability to keep a home adequately warm at an affordable cost (Khandker *et al*. 2010 and Boardman 2010).According to Aduosi (2012) fuel poverty most commonly refers to the situation where individuals are not able to adequately heat in their homes at affordable cost. He further argues that a household in Europe is described as fuel poor if the income it spends on energy exceeds certain percentage of its total income in order to sufficiently heat the household. Thus according to 2010 edition of the World Energy Outlook (WEO) energy poverty is often used interchangeably with the term fuel poverty to refer to a household’s inability to afford energy costs. In an analysis of fuel poverty, the definition has always included all energy services in the home, not just heating.

In view of all that has been mentioned so far, this study uses the term energy poverty, rather than the concept of fuel poverty as it captures the contemporary multiple household uses of energy other than for space heating. It is for these reasons that the study uses energy poverty to refer to the situation of low-income households paying more than 10 per cent of their disposable income to meet energy costs, irrespective of household use or energy source.

2.1.2. Urban Domestic Energy Consumption Characteristics

World energy consumption is increasing at a considerable speed. It has been estimated that on current trends world energy use will grow at 1.4 percent annually until 2030 (UNDP 2011). The current trend in global energy consumption, and the projected future, shows steep increase in energy demand. Primary energy demand is projected to increase on an average by 1.7 percent per year from 2000 to 2030 (FAO 2011). As noted above increasing clean energy consumption is fundamental and has long been tied directly to economic growth and improvement in human welfare. However, according to UNDP (2009) and IEA (2010) around 3 billion people still have no access to modern fuels, relying instead on biomass, as their primary source of domestic energy for cooking and heating. Of the 3 billion people, one billion were already unable to satisfy their minimum energy needs for cooking and heating.

There are, however, vast regional disparities in energy consumption. Developing nations account for more than 80 percent of world population, but consume only about one third of the world's energy. In developing countries, energy consumption per capita is still likely to be only one fifth of what it is in the industrialized world today (IEA 2010).

Ntobeg (2007) pointed out access to energy services for the developing countries accounts 73 percent of biomass fuel but only 27 percent of modern fuels. As Kammen and Kirubi (2009) stated biomass is a primary source of energy for more than 2.6 billion people in developing countries. Among these 653 million people are from sub-Saharan Africa. According to UNDP (2009) and (IEA2010) regarding access to electricity, 1.32 billion people in the world lacks access to electricity. From this, 1.3 billion people are from developing countries, of which 586 million people are from sub-Saharan Africa.

According to OECD (2010), developing countries have the lowest per capita consumption of modern energy of all regions of the world. Per capita consumption of modern energy is on average 10 times less than that of the developed countries. Whereas, countries in more developed world use greater amounts of energy per capita and biomass fuels currently provide only a small share of energy, accounting for only 3 percent of total energy use. World Bank (2011) estimates indicated that in Europe and North

America, the share of biomass fuels in the total energy requirement is low, at 1.2 percent and 1.4 percent respectively.

Africa accounts for 12 percent of the global population, but it consumes only 5.5 percent of global energy while Americans constitute 5 percent of the world's population but consume 24 percent of the world's energy (Wadjamsse 2008). Within the continent, sub-Saharan Africa has the highest and fastest rate of urban population growth with an average of nearly 5 percent per year (World Bank 2009). Sub-Saharan Africa has 9 percent of the world's population and consumes only 2.7 percent of world commercial primary energy. More than 80 percent of its population depends on traditional biomass as their primary energy source (WHO 2009). These people will continue to use wood until they can afford better alternatives (like electricity, kerosene and cooking gas). For these people who use biomass solid fuels to satisfy their energy needs, it is a matter of survival, not choice (UNDP 2009).

The world's population is projected to grow from 6.8 billion of 2010 to over 10 billion by 2050, with almost all the growth taking place in urban areas which are viewed as center of development, modernization and innovation (DFID 2011). According to UN-Habitat (2012), the past fifty years have brought unprecedented changes to the world's urban landscape, with rapidly growing megacities. Currently more than half of the global population, around 3.4 billion people, live in urban areas. The expanding cities enable the development of vital socio-economic structures, but they have been also accompanied by a huge demand for household fuels thus creating noticeable environmental impacts on local and global scale.

Up to now, a number of studies(such as IEA 2008, World Bank 2011 and ESCAP 2012) highlight urbanization usually result in greater use of modern fuels, and a fall in the share of traditional biomass. According to World Bank (2011) in contrast to rural households, urban ones have a wider choice and greater accessibility to modern commercial fuels and energy end-use equipment and appliances and therefore greater potential for fuel switching. ESCAP (2012) further stated as cities develop and modernize, the pattern of residential fuel consumption shifts from the use of traditional fuels to more convenient fuels as a consequence of changing lifestyles and economic development.

Regarding the impact of urbanization on consumption, IEA (2008) emphasized that the total consumption of wood fuels in much of urban Asia has been declining (or growing slowly), due to shifts to other fuels as incomes and city sizes increase. However, as FAO (2010) stated this has not happened in many African cities. A significant proportion of urban households in Africa are still dependent on traditional energy sources for their cooking and heating requirements. According to Barnes *et al*. (2004) the expansion of urban areas has increased the scale of aggregate demand for biomass fuel and total exposure risks to indoor air pollution, even if a significant portion of the population switches to more modern fuels. FAO (2010) found that Africa is losing over four million hectares of forest every year, which is twice the average deforestation rate compared to the rest of the world. The continent alone produces and consumes about half of the world's charcoal production, which is used as a domestic cooking fuel.

Urban centers have long been dependent on the rural hinterlands for their biomass fuels and will continue to impose pressure on surrounding forested land. Wood fuels shortages are likely to occur in many areas of the country, especially near cities. For example, in Burkina Faso the land surrounding the city of Ouagadougou has been completely cleared of woody vegetation for 45 km in all directions (Getis *et al*. 2000). More than 42 percent of households in urban areas of Nigeria are using solid fuel. Among the households that reported use of solid fuel for cooking, the majority (94 percent) were using an open fire without a chimney or hood. More than 80 percent of the total urban households in Kenya and Tanzania mostly used biomass energy in the form of charcoal which becomes a popular urban fuel and a huge revenue generator (FAO 2010). The study in Kenya by Karekezi and Kithyoma (2005) indicates for example, the urban population grew by roughly 4 million in the past ten years and this can lead to an increased demand on biomass resources areas. Three quarter of Kenya's energy consumption is wood, where the demand is increasing for wood at 3.6 percent and for charcoal at 6.7 percent.

In view of all that has been mentioned so far, one may suppose that as urban areas develop in Africa, biomass supplies are depleted in a larger radius around the city, and thus the relative price of wood fuels may increase due to growing fuel scarcity in urban centers, thereby undermining the livelihoods of the urban poor. The heavy dependence together with inefficient utilization of biomass resources for energy have resulted in high depletion of the forest resources which gradually contributed not only to the increasing scarcity of biomass fuels but also the combustion of these fuels can lead to serious health damage.

According to Wickramasinghe (2007) the reasons for not adopting the sources that are labeled as 'clean fuels' in cooking are multiple and the issues remain beyond the domain of physical access to cleaner fuels. Meikle and North (2005) suggested three main reasons for the heavy reliance on traditional fuels for urban energy needs. These are low income levels, limited energy infrastructure and erratic supplies of modern fuels.

The type of energy used in a household has significant consequences for the health of family members. The study by Clancy *et al.* (2003), Barnes *et al*. (2004), Meikle and Bannister (2005), Kammen and Kirubi (2009) and TERI (2010) indicated that most of the households who burn biomass fuels over open fires or in inefficient stoves would face direct and indirect negative effects on their health due to high quantities of smoke and particulates.

WHO (2011) noted that there are more people dying from exposure to indoor air pollution than from malaria or tuberculosis today. It is estimated that nearly two million people die from the adverse effects of indoor air pollution such as acute respiratory infections, chronic obstructive pulmonary disease, pneumonia, lung disease, bronchitis, internal disorders and eye problems. Together these studies provide important insights into the absence of efficient and affordable energy services and the use of polluting fuels to meet basic needs can severely damage the health of large numbers of people in the world, particularly in Africa.

Therefore, the concern that environmental degradation caused by unsustainable energy use could rapidly develop into a crisis situation of unmanageable proportions gave energy-environment issues a more and more important role in international politics. Both governmental and nongovernmental organizations in many developing countries have been trying to address the heavy dependence on biomass fuels by adopting different strategies, including the promotion of fuel substitution for increased use of modern fuels and improved stoves.

World Bank (2011) and ESCAP (2012) noted that general economic development, which brought income growth, would to some extent trigger fuel switching particularly in urban areas. Thus, households easily switch to electricity which will be important in reducing the demand for traditional fuels such as firewood. According to Clancy *et al.* (2003) the introduction of more efficient or fuel saving cooking appliances or stove technologies has the potential to reduce the growing pressure over forest resources of rural hinterlands induced by the great demand for fuel wood in urban centers. Reddy (2004) and Heltberg (2005) underline the importance of education or awareness, in addition to other factors accompanying development, such as urbanization and electrification, to the process of fuel switching. Whereas others such as Alam *et al.* (1998) and Barnes *et al*. (2004) consider governmental policy as an important influencing factor for household energy choices, typically in the form of subsidies for modern fuels by keeping most people to use them for cooking to arrest deforestation by suppressing demand for firewood.

Recently energy has come to dominate global agenda since energy poverty poses serious threats to economies, national security, the environment, and public health throughout the world. According to Clancy (2000) and Cecelski (2004) it disturbs all aspects of human welfare like agricultural productivity, access to water, education, healthcare, job creation etc. Households and countries as a whole cannot develop economically if a significant portion of the population is living in energy poverty. As ESCAP (2008) noted billions of people worldwide are energy poor and require access at affordable prices to maintain a minimum standard of living. Lack of energy services is directly correlated with the major elements of poverty, and aggravates many social concerns, including inadequate healthcare, lack of education, unemployment and inequity as well as threatens the achievement of the Millennium Development Goals.

Globally, 1.3 billion people lack access to electricity. Many of these people have little chance of seeing the electric grid reach their community (Aduosi 2012). Each day, close to 50 percent of the world population worldwide cook and heat their homes using biomass (charcoal, firewood, dung, coal, straws, grasses and other solid fuels) usually on open fires or traditional stoves (WEO 2010).

The problem of energy poverty is found to be acute in Africa where modern fuels are difficult to procure (Clancy *et al*. 2006). According to Aduosi (2012) in Africa two out of three households lack access to convenient, efficient and reliable forms of energy to satisfy their basic needs and to perform economic tasks. Drexler (2004) pointed out Africa has the lowest electrification rate with 34.3 percent, followed by developing Asia with 67 percent and Latin America with 86.6 percent.

Karekezi and Kithyoma (2005) identified a positive correlation between poverty levels and biomass use in many countries of Africa. Kammen and Kirubi(2009) stated that sub-Saharan Africa is one of the places where energy poverty is greatest, and the region with the highest levels of the population in poverty, also has the least access to modern supplies of commercial energy. Despite the accelerated electrification programme, WHO (2009) estimated that over 70 percent of the population of sub-Saharan Africa is without electricity. According to OECD (2010) the number of new electricity connections in sub-Saharan Africa is outpaced by population growth. Electricity consumption per person in the region is only 0.9 percent (Barnes *et al*. 2010). Moreover, half of the population in sub-Saharan Africa is expected to remain without access to electricity even in 2030.

In his study, Aduosi (2012), argued not only is infrastructure to deliver energy weak, but in cases where infrastructures are available, physical access to energy is hampered by frequent shortages of LPG, irregular supply of grid electricity, frequent power cut, high cost of energy appliances and affordability problems among others. According to AfDB (2014) “Power Africa” is a new five-year American presidential initiative launched by President Barack Obama during his Africa Tour in July 2013. The initiative aims at supporting economic growth and development by increasing access to reliable, affordable, and sustainable power in Africa. During his recent trip to Africa, President Obama announced plans to direct up to USD 7 billion in support to increase the number of people with access to power in sub-Saharan Africa.

As UNEP (2012) stated the Obama administration's power Africa initiative aims to double the number of people across the continent to have access to power and to ease what business leaders on the continent describe as their biggest problem: a lack of reliable electricity. The goal is to double access to power in the region, focusing initially on six countries: Ethiopia, Ghana, Kenya, Liberia, Nigeria and Tanzania.

Clancy *et al*. (2003) revealed that fuel poverty is a serious problem, affecting millions of households and individuals in UK and they also showed that fuel poverty in the UK was not of the same order or intensity as that of sub-Saharan Africa. In a study conducted by Boardman (2014), it was shown that poverty and fuel poverty are linked, but not synonymous concepts. Raising income can lift a household out of poverty, but rarely out of fuel poverty. The fuel poor tend to live in energy inefficient properties as a result of insufficient capital expenditure. Fuel poverty, indeed, occurs because of a combination of low income and energy inefficient homes.

What Boardman (2010) is reassessing the evidence on the causes of fuel poverty, the effectiveness of the policies that have been implemented and identifying some possible new initiatives. As she indicated although fuel poverty is a serious and significant social problem in Western Europe, its acceptance has been slower and has been acknowledged by campaigners, academics and politicians since at least 1975. Even nowadays there is political awakening to the issue of fuel poverty; nonetheless fuel poverty remains a vicious and enduring problem in the region. Clancy *et al.* (2003) and Boardman (2010) revealed that fuel poverty is a serious problem, affecting millions of individuals in Western Europe. Recent study undertaken by Boardman (2010) reveals that 12 percent of all households in Western Europe live in fuel poverty. Though the number of households in fuel poverty in UK was declining steadily until 2003, since 2004 the number of fuel poor households has risen consistently every year. In 2009, 16 percent of all households in UK were considered fuel poor since they have difficulties heating their home.

In exploring the changing patterns of energy use in the household, researchers such as Alam *et al.* (1998), Barnes *et al.* (2004), Reddy (2004) and Nkomo (2007) have developed the notion of an energy switching hypothesis as a model to explain the shift between traditional solid fuels and modern non-solid fuels in order to meet household's energy needs as the household pass certain income thresholds. These writers consistently indicate a strong correlation between household income levels and the types and amounts of fuel used for cooking. The central idea of energy ladder hypothesis is to describe the patterns of energy usage associated with certain income levels. It prescribes income of the households to be the sole factor and it is a key determinant in the selection of a fuel and the movement towards other alternatives. It does not appropriately account for other factors that are likely to affect household energy services. With rising incomes, urban families are able to switch from lower-efficient biomass fuels to higher-energy-value modern fuels and equipment for cooking and heating.

The term fuel switching is commonly used in their literature to refer to the fuel transition from relatively inefficient fuels to more efficient fuels due to the income of the households. Energy switching hypothesis shows a sequential change of fuels as income rises and it is used to describe the way in which households climb the ladder with increase in economic status (Khandker *et al*. 2010). According to OECD (2010) households at lower levels of income and development tend to be at the bottom of the energy ladder, using fuel that is cheap and locally available but not very clean nor efficient. As families gradually increase their incomes, they can afford more modern appliances, and they will make greater use of energy that is cleaner and more efficient.

Reddy (2004) looks at household energy choices for sample of households residing in the city of Bangalore and employed a series of binomial logit models to determine the choice between each pair of energy carriers, to explain the shifts in and the pattern of consumption of different fuels used for cooking and water heating and confirms the hypothesis that households ascend an energy ladder.

According to Reddy (2004), household fuel choice has often been conceptualized using a three-stage fuel switching process. The first stage is marked by least efficient, most polluting fuels at the bottom rung of the ladder. In the first and lowest stage, households depend solely on solid biomass, deriving energy from the combustion of firewood and animal wastes. In the second stage households move to transition fuels such as kerosene and charcoal in response to higher incomes and factors such as deforestation and urbanization. In the intermediate stage households shift towards fuels that burn more efficiently but still have notable emissions, including charcoal, kerosene and coal. In the third phase, as a household gains socioeconomic status, it ascends the ladder to cleaner and more efficient forms of energy.

The study by Masera *et al.*(2000), Heltberg (2005), Ntobeg (2007), Gundimeda and Köhlin (2008), and Alemu and Köhlin (2008) challenged the energy switching hypothesis and suggest the fuel stacking model which shows the use of multiple fuels rather than completely switching from one fuel to another. Gundimeda and Köhlin (2008) argued stacking is an issue that focuses on the use of multiple fuels at one time. According to Masera *et al.*(2000) in many households, traditional stoves are used at the same time as improved cook-stoves, or the different stoves may be used for different foods. Together these studies provide important insights into the simultaneous use of different fuel regardless of income levels.

According to Barnes *et al.*(2004) and Ntobeg (2007) the availability of electricity in urban areas seems to act as a catalyst for people to switch from traditional to modern fuels. Nonetheless, it should be known that the coming of electricity not as a replacement for the firewood as such, but merely as supplement. For example, according to Farsi *et al.* (2005), despite a major shift away from the use of biomass fuels towards commercial fossil fuels and electricity over the last couple of decades, in urban areas, there are still many Indian high income households who opted to purchase fuel wood rather than substitution with electricity for their primary source of cooking energy.

Some writers (like Mulugeta 2007; Wickramasinghe 2007; TERI 2010; and Köhlin *et al.*2011) assumed that cleaner fuels that have high energy content are priced higher than the biomass ones that are used in less efficient stoves. TERI (2010) and Köhlin *et al.* (2011) noted cost is the major reason which forces households to stay with fuel wood as the primary base fuel. Higher financial burden hampers the movement of households up on the energy ladder, as the cleaner fuels are priced higher than the traditional ones. Bereket (2001) further pointed out the transition from biomass to modern forms of energy is particularly difficult for poor households not only because of the high costs of modern energy sources, but also because of the relatively high capital costs of the means of energy conversion (such as electric stoves). While according to Wickramasinghe (2007) the tendency for increasing the number of households depending on solid biomass for cooking and the difficulty of switching over to cleaner fuels are high not only due to the increasing cost but also because of demographic factors such as increasing family members.

Several studies (such as Masera *et al.* 2000, Farsi *et al.* 2005, Alemu and Kohlin 2008) emphasize the use of multiple fuels for various reasons. For example, in case of Masera *et al*. (2000) households do not make a full switch to modern energy sources. Fuel wood is very seldom replaced entirely when families adopt LPG, none of the family ceased using fuel wood even in the households that have been using LPG for many years. The longitudinal survey conducted by Masera *et al*. (2000) in the region of Central Michoacan, Mexico, demonstrates the multiple fuel models rather than the energy switching scenario. They discovered that, rather than making concise transitions from fuel to fuel, or stove type to stove type, along the energy ladder, families in Michoacan often show the pattern of fuel stacking. According to them, fuel wood is very seldom replaced entirely when families adopt LPG, none of the family ceased using fuel wood even in the households that have been using LPG for many years. They concluded that multiple cooking fuel use patterns have been reported frequently in the households by taking the technical, socioeconomic and cultural aspects into consideration.

Heltberg (2004) analyzed the determinants of fuel switching using comparable household survey data from Brazil, Ghana, Guatemala, India, Nepal, Nicaragua, South Africa, and Vietnam. He argued that larger households are more likely to consume multiple fuels, both solid and non-solid. The study by Meikle and Bannister (2005) found that households in Tanzania, whether poor or non-poor, do not make exclusive use of one fuel, nor is only one fuel type used for only one activity. Instead for a mixture of practical and cultural reasons they use a mix of modern and traditional fuels.

Similarly, Kammen and Kirubi (2009) found that complete switching, where one fuel totally substitutes for another, is rare. Instead of moving up the ladder step by step as income rises, most households tend to consume a combination of fuels for cooking purpose depending on many more factors. This view is supported by Farsi *et al.* (2005), Rajmohan and Weerahewa (2007) who wrote that income is not the only factor that determines households' energy consumption pattern but, in addition to income, there are many other characteristics that are also seen to play a role in fuel selection amongst households. The choice is often not confined to a single fuel, but rather multiple fuel use is the norm for most households. Households choose to use more than one fuel because they want to increase the security of supply. Use of multiple fuels provides a sense of energy security. This is because complete dependence on a single fuel or technology may make households vulnerable to price variations and unreliable service.

Meikle and Bannister (2005), and Abebe and Koch (2011) assumed the reasons for multiple fuel use might generally be dependent on households' socioeconomic characteristics such as income, age, education level, sex and occupation of the household head, type and ownership of improved biomass cook stoves, type and ownership of substitutable cook stoves, children and adults in the household, house ownership and characteristics of the house, fuel availability, fuel prices, cultural preferences, demographic distribution and physical environment.

Others like Abrahamse (2011) argued that it is not sufficient to focus only on socio-economic determinants rather a wider set of attitudinal and psychological variables together with socio-demographic variables must be considered. The study by Olabisi (1999) viewed environmental factors in addition to socio-economic factors as the major determinants of per capita energy demand and consumption.

2.1.3. Urban Domestic Energy Use and Gender Inequality

Gender is appearing increasingly in the mainstream energy publications mentioned earlier, though often as a separate topic not integrated with strategies and solutions. The focus in the literature is mainly on poor rural women and on micro household and project level analysis (Cecelski2003). Gender is a concept which refers to a system of socially, culturally, and politically defined roles and responsibilities that women and men play and the power relations between them (Aduosi 2012). As Clancy *et* *al.(*2003) discussed it is about reaching a better understanding of how communities work from the perspective of relationships between men and women. The differences in roles and behaviors between men and women that systematically may favor one group and may give rise to gender inequality which hurts all members of society. According to World Bank (2011) such inequality can lead to inequity between men and women in terms of wealth, leadership, health status, access to food, education, health care and other services.

Generally women are in a worse position than men as a result of gender roles; they have fewer opportunities, lower status and less power and influence than men Nijenga, B., and Clancy J. (2005). Women are seen as a special group whose specific needs have to be addressed (Cecelski 2000). The energy strategies that are intended to assist people to move out of poverty must take these gender aspects into account (Cecelski2003).

Adousei (2012) further noted that energy needs for men and women are different and therefore policies must address these different needs. They contend for example that the energy required by men and women in the home is not the same and therefore policy must aim at taken care of energy needs by both genders. Therefore, if energy is a key factor in moving people out of poverty, through improved income generation, or is a significant contributor to well-being, addressing gender issues in energy will make an important contribution to reducing poverty (Ceceslki 2000). A number of energy programs are starting to pay closer attention to gender and are launching important initiatives, encouraged by the development of national and international networks on gender and energy (Cecelski 2003).

Writers such as UNFPA (2002), Cecelski (2004) and Sarkar (2005) have been arguing that women are more likely to experience persistent poverty due to domestic chores, scarcity and insecurity of income, higher rates of unemployment, oppression by the gender division of labor both inside and outside home and the associated ideologies and behavioral norms, illiteracy, early marriage, likelihood of being a single parent and having a large family.

According to Cecelski (2004) women are deprived and discriminated members of the society with limited access to resources and greater risk of poverty. Sarkar (2005) further stated that there are reasons to be concerned about the welfare of FHHs, since women are subject to discrimination in labor, credit and a variety of other markets and they own less property compared to men.

Wickramasinghe (2007) found out the linkage between gender and poverty whereby 70 percent of the nearly 1.3 billion people living on less than a dollar a day are women. World Bank (2011) further points out that FHHs have become increasingly connected with poverty and having low socio-economic status as FHHs typically work for lower wages and have less access to assets and productive resources compared to men owing to gender bias against women and are thus more likely to be poor.

According to UNDP (2011) the links drawn between the feminization of poverty and household headship derive first, from the idea that FHHs constitute a disproportionate number of the poor, and; second, that they experience greater extremes of poverty than MHHs. For example, Ramaprasad (2008) in India and Njenga and Clancy (2005) in Sri Lanka have shown that FHHs are poorer compared to their male counterparts.

Baron *et al*. (1994) provide evidence that majority of FHHs in Brazil were in the very poor category. FHHs tend to have lower household income compared to other households because of lower average earnings compared to that of MHHs. Karekezi *et al.* (2002), in their study in Kenya observed a higher proportion of the poor both in the rural (54.1%) and urban areas (63%) belong to FHHs.

Based on the standard of living index measure of poverty, FHHs are marginally poorer than their male-headed counterparts (Ramaprasad 2009). Barros *et al.* (1997) cited in Ramaprasad (2009) show that FHHs have worse social, economic and demographic features compared to their counterparts and are thus more likely to be poor. They provide evidence that FHHs in Brazil tend to have lower household income compared to other households because of lower average earnings of the female heads.

The nexus between gender and energy has successfully emerged on the international agenda, and is widely viewed as one of the critical pathways for linking energy interventions to the Millennium Development Goals (MDGs) (Cecelski 2004). According to Aduosi (2012) the concept of gender and its relationship with energy is still hotly contested with some academics claiming that all human beings irrespective of whether “he is a he or she is a she” needs energy and that there should be no distinction between energy for women and men.

Kammen and Kirubi (2009) assume that energy is ‘gender neutral’; making it available and benefiting all male and female members of society equally. In an investigation into gender, Cecelski (2004), Clancy (2006), Wickramasinghe (2007) and Aduosi (2012) found that despite many efforts, gender inequality is still widespread and it persists at every level of the energy sector. It is becoming more and more apparent that access to energy services is particularly important for women, given that like health and education, energy service is not gender neutral. UN-Energy (2005) cited in Adousei (2012) noted that access to energy services is particularly important for women, given that energy services and technologies are not gender neutral. Energy is sensitive to gender as men and women have different energy needs and they have different perceptions about the benefits of energy services and do not benefit equally from access to energy.

Drexler (2004) demonstrated that in many developing countries women are particularly affected by lack of accessible and affordable energy services due to their traditional roles, household responsibilities, and low social and political status. Thus, the gender component of energy poverty is attributed to the fact that 70 percent of people living in poverty are women. Clancy (2006) pointed out since household energy is primarily women’s responsibility, they will be the direct beneficiaries in any improvements in availability or diversification in choice of energy carrier or conversion technology, and men can be indirect beneficiaries of access to modern energy forms. For example, Njenga and Clancy (2005), in his study on SriLanka, argued that women see electricity as providing the means for reducing their workload, improving health, and reducing expenditure while men see the benefits of electricity in terms of leisure, quality of life, and education for their children. The study in the town of Arusha by Meikle and North (2005) further showed that FHHs make more use of electricity for household activities than MHHs since the husband in MHHs is more concerned with expense rather than convenience. This view is also shared by other researchers such as Cecelski (2004) and Köhlin *et al.* (2011) emphasized the benefits of providing electricity to women in terms of easing household chores and increasing efficiency.

Some writers (Clancy *et al*. 2003; Cecelski 2004; Meikle and North 2005; Karekezi and Kithyoma 2005) have the opinion that inefficient use of biomass fuels in the traditional stoves has direct negative impacts on women and children. As already stated, the responsibility for household energy provision affects women's health disproportionately since they are generally engaged in household cooking and hence most likely to suffer serious smoke-related health hazards. Women are the ones most affected by higher levels of lung and eye diseases due to the longer hours of exposure to smoke and particulates in smoky kitchens. For example, according to WHO (2009) about 120 million women and children in Nigeria are vulnerable to dangers associated with firewood smoke, and about 98,000 especially women and children died annually from smokes inhaled during cooking with firewood.

As Clancy (2006) noted, for urban households energy costs can form a significant part of household budgets, with FHHs considered to be in a worse position than MHHs. In urban households' survey in Tanzania, it was found that FHHs use a higher average percentage of their income than MHHs for purchasing energy. This implies that FHHs suffer more than MHHs from rapid energy price rises. As Cecelski (2004) noted women's role has been either minimized or totally neglected in the policy formulation as well as in project design despite the fact that they are the primary users of energy at the household level.

Overall, there seems to be some evidence to indicate that energy can be a vital entry point for improving the position of women in households and societies. Their lack of access to energy services is a serious impediment to assuring livelihood security reinforces gender inequalities and therefore contributes to poverty. Therefore, targeting women has become one means for gender-sensitive poverty alleviation.

According to UNDP (2011) women should be focus of energy expansion plans; bringing energy to women and meeting their energy needs will help to empower them and lift communities out of poverty. Therefore, greater attention to the needs and concerns of women in these areas could help governments promote overall development goals like poverty alleviation, employment, health, and education through improved energy policies. In a study conducted in Ghana by Aduosi (2012), it was shown that improving households' access to energy and maintaining regular supply is considered central not only to achieving the MDGs goals but also to sustaining the socio-economic conditions of the people especially for women who are burdened with securing energy in most households.

2.1.4. Urban Domestic Energy Use and Equity Problem

Urbanization and urban growth are considered as a modern way of life manifesting economic growth and development. Contrary to this assumption, however, urbanization is not without its problems. In a study conducted by UN Habitat (2012), it was shown that urbanization does not provide only opportunities but it also creates formidable problems to its residents. The rapid growth of population in the urban areas has resulted in a sudden rise in overcrowding, poverty, growing urban unemployment, deterioration and scarcity of housing, lack of access to essential needs of human beings, inadequate income and lack of health care, unsafe shelter, crime, and other social problems.

Income is an important indicator to identify which people are likely to lack the resources to achieve a socially acceptable standard of living. According to World Bank (2011) within urban areas inadequacy of income becomes a significant factor underpinning many other deprivations that the urban poor are exposed to. Primary reliance on a monetized economy constitutes one of the key differences between urban and rural poverty. UNDP (2011) stated urban dwellers generally face higher living costs than rural dwellers as they are characterized by a higher degree of commercialization of goods and services than rural areas. The urban poor may have even greater problems as their incomes have not kept pace with the rising prices. Poor urban households are more exposed to changes in income and prices for basic goods and services, and their vulnerability is exacerbated by poor housing, the deterioration of public services, and increasing tension and violence in congested urban settings and typically spend relatively more on food than do rural households.

The World Bank (2011) has estimated that the worldwide urban population is expected to double within 30 years, but the numbers of urban poor are expected to increase at a greater rate. UNDP (2011) stated that for many developing countries particularly in sub-Saharan Africa, the pervasive nature of urban poverty constitutes an enormous challenge to their development effort. People in sub-Saharan Africa specially are among the poorest in the world both in real incomes and in access to social services. In this sub-region of Africa 300 million people, almost half of the region's population lives on less than one USD a day. Karekezi and Kithyoma (2005) have noted that urban poverty in the region is growing with the gap between the poor and the rich getting wider and the proportion of the poor getting bigger.

As already stated rural energy use has been the focus of most previous studies, although the body of knowledge on the energy-poverty nexus in urban areas is beginning to grow recently. As Wickramasinghe (2007) noted patterns of household energy use in urban areas are far more complex than in rural areas. Urban residents have better access to energy services than rural residents however urban residents behave differently from the rural ones in regard to energy consumption level. Barnes *et al.* (2010) further viewed while a significant part of the problem lies in rural areas, significant numbers of urban households, who continue to rely on biomass-based cooking fuels, are also at risk.

Wickramasinghe (2007) and TERI (2010) found a direct correlation between poverty levels and quality of energy used among the urban and peri-urban poor. They stated energy poverty is a growing problem among low income groups residing in urban areas as they always have limited access to clean fuels. Similarly, Barnes *et al.* (2010) assert that those people who are living in energy poverty, have little or no access to clean cooking facilities and do not benefit from the economic and social opportunities that access to modern energy brings.

Overall, there seems to be some evidence to indicate that modern energy is an essential input for sustaining people's livelihoods and it is considered as one of the vehicles for poverty alleviation. Access to sustainable sources of clean, reliable and affordable energy has a profound impact on multiple aspects of human development. People without modern energy services must spend more of their time and physical energy on securing sustenance and, therefore, have fewer opportunities to engage in educational and income-generating activities. The social and economic inequality as well as the marginalization these people face are worsened by their lack of or limited access to modern energy services thereby trapping them in a vicious cycle of poverty.

Many writers (such as Cecelski 2000; Clancy *et al.* 2003; Drexler 2004; Pachauri and Spreng 2004; Karekezi and Kithyoma 2005; Meikle and Bannister 2005; Barnes *et al.* 2004; Nkomo 2007; and Khandker *et al.* 2010) have concluded that low income households usually spend a higher portion of their available income and more time for energy services than do the rich. Poor people often pay more for energy both absolutely (paying higher unit prices) and relatively (as a percentage of their income) than do the non-poor.

Pachauri and Spreng (2004) noted that poor households spend less cash on energy than the more wealthy households, but the percentage of income the poor spend on energy is typically much greater. Recent empirical study by Khandker *et al.* (2010) indicates that a poor urban household may spend up to 20 percent of their income on fuels whereas the wealthy spend less than 5 percent.

In the early 2000s, the World Bank has carried out a global survey of 45 cities and 20,000 households. It is found that poor urban households spend a significant portion (15 to 22 percent) of their cash incomes on energy because cooking with fuel wood is inefficient compared with cooking with modern fuels. Despite paying higher prices for useable energy, poor households use less useful energy per household due to the inefficiency of traditional fuel-using cooking stoves. One consequence is that less food is being cooked and less water is boiled for drinking and other hygienic purposes (World Bank 2007). TERI (2010) also indicated that the low income households in India allocate about 12.8 percent of their total expenditure for energy fuels, which is double the percentage amount, spend by the high income urban households.

Poor households in South Africa spend about 15-28 percent of their income on energy, and the poor in Arusha, Tanzania, spend as high as 40 percent of their incomes (Meikele and Banister 2005). The survey in Addis Ababa alone shows over 15 percent of the cash income of the lowest income group is spent on cooking fuel (Alemu and Köhlin 2008). The evidence presented in this section suggests that the higher financial burden faced by the poorer households in meeting their energy needs.

2.1.5. Current Status of Domestic Urban Energy Use Patterns in Ethiopia

Poverty in Ethiopia is a central challenge and fundamental problem (MoFED 2012). According to UNDP (2009) all standard measures of poverty identify Ethiopia as one of the poorest countries in the world. A recent official estimate indicated that about 30.6 percent of the population was estimated to live under the poverty line.

With increasing population growth and rural-urban migration, the urban population has increased in Ethiopia at the rate of 4.4 percent per annum during the last 15 years with high incidence of urban poverty (CSA 2008).Studies by Emebet (2008), Berhanu (2011) and MoFED (2011) indicated that in urban Ethiopia, there has been a significant increase in the percentage of FHHs in recent years. It has commonly been assumed that as urbanization increases, the incidence of urban poverty also increases in-depth and intensity in cities of most developing countries of the world including Ethiopia. Although in urban areas of Ethiopia poverty incidence has increased for both MHHs and FHHs, FHHs are considered to be in a worse position than MHHs.

A study conducted by Emebet (2008) has shown that the average income per family member in the FHHs was less than that of the MHHs in five major cities of Ethiopia including Addis Ababa. Many of the FHHs are mainly engaged in the informal sectors and were found to be not only lacking their own houses but also living in overcrowded rooms and poor housing conditions with a serious lack of basic facilities. The number of women living in poverty has increased disproportionately to that of men due to a host of socio-economic biases against women as well as their disadvantaged position in the society.

The energy use pattern of the country indicates predominance of biomass energy to meet baking and cooking needs and such high dependence on biomass energy sources is contributing to the problem of deforestation and soil erosion (World Bank 2007;Alemu and Kholin 2008, IEA 2010, and Yonas *et al.* 2013). According to Mehari (2011) in Ethiopia, the household sector utilizes the bulk of the country's energy. Nearly 90 percent of the total national energy consumption is in household sub-sector while industry, agriculture, transport, service and commerce sectors together constitute the remaining 10 percent of the energy consumption.

Ethiopia is believed to have a huge potential of other alternative energy resources, much of the potential energy resources are still unutilized and the existing supply of fuels could hardly cope up with the ever increasing demand for more fuel domestic requirement (MoWE 2009). As Zenebe (2007) pointed out electricity and petroleum products are the two modern fuel sources used in Ethiopia accounting for about 2 percent and 6 percent of total energy consumption, respectively. Among petroleum products, kerosene is the most important one, mainly available in urban areas, although there is some consumption in rural areas.

Ethiopia has the capacity to generate over 50,000 MW from water, 1.3 million MW from wind, and 10,000 MW from geothermal energy sources (MoWE 2011). Despite this huge potential, per capita power availability is significantly lower than many African countries. The electric energy consumption per capita (77 kWh) is one of the lowest among the developing countries (Dereje 2013).

Nonetheless, during the past few years, government investment in the power sector has increased substantially and the power supply has improved considerably. According to Araya and Yishak (2012), until 2010, the overall production of electricity has remained 2,000 MW. But, with expansion works, the country currently has an installed electricity generating capacity of 2,268 MW from hydro, wind and geothermal energy.

The National energy policy envisages the development of hydro, geothermal, natural gas, coal, wind and solar energy resources based on their economic viability, social and environmental acceptability. The National energy policy emphasized the need for equitable distribution of electricity in all regions in support of the nation's socio economic development (Dereje 2013). The assumption taken here is that the target of increasing the present electricity access to 50 percent will be achieved within 5 years (EEU 2012).

The government of Ethiopia with the collaboration of Chinese government prepared solar and wind master plan for the whole country, which can be very useful to identify the gross amount and distribution condition of wind and solar energy resources, construction conditions, cost and other limiting factors of wind and solar power generation projects (Dereje 2013) The government of Ethiopia is also planned to produce 1.8 billion liters of liquid bio-fuel by 2015,consisting of 195 million liters of ethanol and 1.6 billion liters of biodiesel (Gemechis 2014).

EEU (2012) is undertaking huge electrification program to increase the present low rate of electricity access and plans to construct several new generating facilities. Currently, under the government's five-year Growth and Transformation Plan (GTP), huge electrification program is being undertaken to increase the present low rate of electricity access. Large power plants are under construction with a total installed generation capacity of 8450 MW. The Grand Ethiopian Renaissance Dam (6000 MW), the *Gilgel-Gibe* III (1870 MW), *Genale-Dawa* (254 MW), *Adama* II wind power (153 MW) and the 70 MW geothermal power development in the rift valley are the ongoing power projects expected to rescue the country from power crisis (MoWE 2011).

The country is focusing on the development of the huge hydro potential it possesses in the Eastern African Region (AfDB 2014). EEU's plan addresses the power interconnection issue with neighboring countries to meet the future demands for electric energy in these countries from environmentally friendly and cheap hydro energy of Ethiopia (Dereje 2013). Hence, Ethiopia should widen and deepen her cooperation with the neighboring countries in the political, economic, and social fields for the mutual benefits of all the population in the region through integrated development of their power systems and interconnection links to effect cross-border electricity trading (EEU 2012).

The government of Ethiopia emphasizes on the production of ethanol from sugar cane, and bio- diesel from *jatropha,* castor bean and palm plants in different agro-ecological zones of the country (FfE 2011). As part of the Growth and Transformation Plan (GTP), the country envisages to produce 1.8 billion liters of liquid bio-fuel by 2015, consisting of 195 million liters of ethanol and 1.6 billion liters of biodiesel. In Ethiopia, the total potential land that is available for the production of feedstock for biodiesel is estimated at about to 23.3 million hectare of land (Gemechis 2014). The total land allocated for bio-fuel companies in 2007 was about 300,000 hectares, which has increased to more than 600,000 hectares in 2010 (FfE 2011).

Despite government's efforts, it is evident that still most urban households have long been dependent on the rural hinterlands for their fuel needs. Alemu and Kholin (2008) and Abebe and Koch (2011) noted even though urban households have better access to commercial energy than the rural population, a substantial portion of the urban households continue to rely on wood fuels for their cooking needs. In a study conducted in Tigrai region of Ethiopia by Alemu and Kohlin (2008) almost all sample urban households were using electricity; however no more than 20 percent were found to have adopted the electric cooking appliance.

The reasons for multiple fuel use are varied and not dependent on economic factors alone. Bereket (2001), Zenebe (2007), Alemu and Kholin (2008), and Abebe and Koch (2011) argued that despite the fact that income is one of the consistently significant factors determining household decisions to adopt new technologies, other household characteristics were also important factors in the adoption decision of the improved biomass cook stoves.

2.2. Conceptual Framework

In many countries, urbanization has resulted in a shift from traditional to modern energy sources. As urbanization accelerates, typical activities of the average urban resident become usually more modern and energy-intensive than the activities of the rural resident. This leads to rapidly growing demand for modern energy resources.

Surveys such as that conducted by Samuel (2002) have shown that the energy transition hypothesis is confirmed in urban Ethiopia and the probability of consuming traditional fuels in general declines with increase in income. This differs from the findings presented by Bereket (2001), Alemu and Kholin (2008), Abebe and Koch (2011) and Yonas *et al.* (2013) who found that it is unusual for families to make a complete fuel switch from one fuel to another; rather, they begin to use a modern fuel without abandoning the traditional one. Thus, many households satisfy their needs by using energy combinations rather than replacing wood fuels with conventional fuels. Households choose to use more than one fuel because they want to increase the security of supply.

It is wrong to assume that electricity substitutes biomass use in urban areas, in spite of the fact that there are substantial number of urban households with access to electricity. The most important issue is not electrification alone since the majority makes no use of electricity for cooking. Instead most people often continue to cook with biomass fuels. Even the majority of higher incomes households do not currently substitute wood fuels for other conventional fuels for the purpose of baking and cooking. Thus, this implies, as opposed to the energy ladder hypothesis, wood fuels are not perceived as inferior goods by urban and peri-urban households. Even the price of wood fuels is growing higher, a substantial portion of the urban people are not looking these fuels as inferior rather still continue to be used in all income groups.

Even with the substantial household electrification program, most newly electrified households continue to use wood fuels because they cannot afford the modern cooking appliances. Access to electricity is not the main problem to the majority of the urban dwellers, but rather most people are unable to afford the appliances that make use of such conventional energy source. Expanded access to electricity, which most households use primarily for lighting, is unlikely to reduce the demand for biomass in the study area.

As indicated in the literature, household income is seen to be powerful determinant in choosing desired kind of fuel. It is evident switching to modern energy sources could lead to time and cost saving when using efficient appliances but still the reality is most households could not shift totally to use conventional fuels due to a number of factors that can influence the fuel consumption of a household.

Urban poverty is a growing phenomenon and urban dwellers generally face higher living costs than rural dwellers and typically spend relatively more on food than do rural households (DFID 2011 and UNDP 2011). It is evident that energy poor persons spend a large portion of their income and time to get energy fuel. The urban low income households may have even greater problems as their incomes have not kept pace with the rising prices. The cost of fuel is a burden on incomes already inadequate to purchase food for the household, thus risking the nutritional status of families.

The majority of the urban and peri-urban low income residents are disproportionately affected from the impacts of scarcity of fuels and indoor air pollution as they suffer a lot due to their low social and economic status in the society. In the light of the theories cited in the related literature above, this study investigate the linkages between income poverty and gender inequalities with respect to the consumption of domestic end-use energy among urban and peri-urban households in one of the medium level towns of southern Ethiopia, Arba-Minch town.

It is evident that urban households have a wider choice and greater accessibility to commercial fuels and consume multiple cooking fuels depending on the result of complex interactions between demographic, socio-economic and technical variables beside household income (Meikle and Bannister 2005).

In the present study there is obviously one continuous dependent variable, which is end-use household energy consumption in terms of heat value (MJ) and a number of continuous and dichotomous independent variables. The most important parameters selected, in the current analysis, that are considered as predictors of the pattern of household energy consumption are: income of the households, prices of the fuels, household size, gender, age, occupation, education level of the household head, marital status, cost and performance of end-use technology being used, ownership of housing unit and characteristics of quality of housing unit. An association was drawn between these various factors and total household end-use energy consumption by employing a multivariate analysis model.

CHAPTER THREE

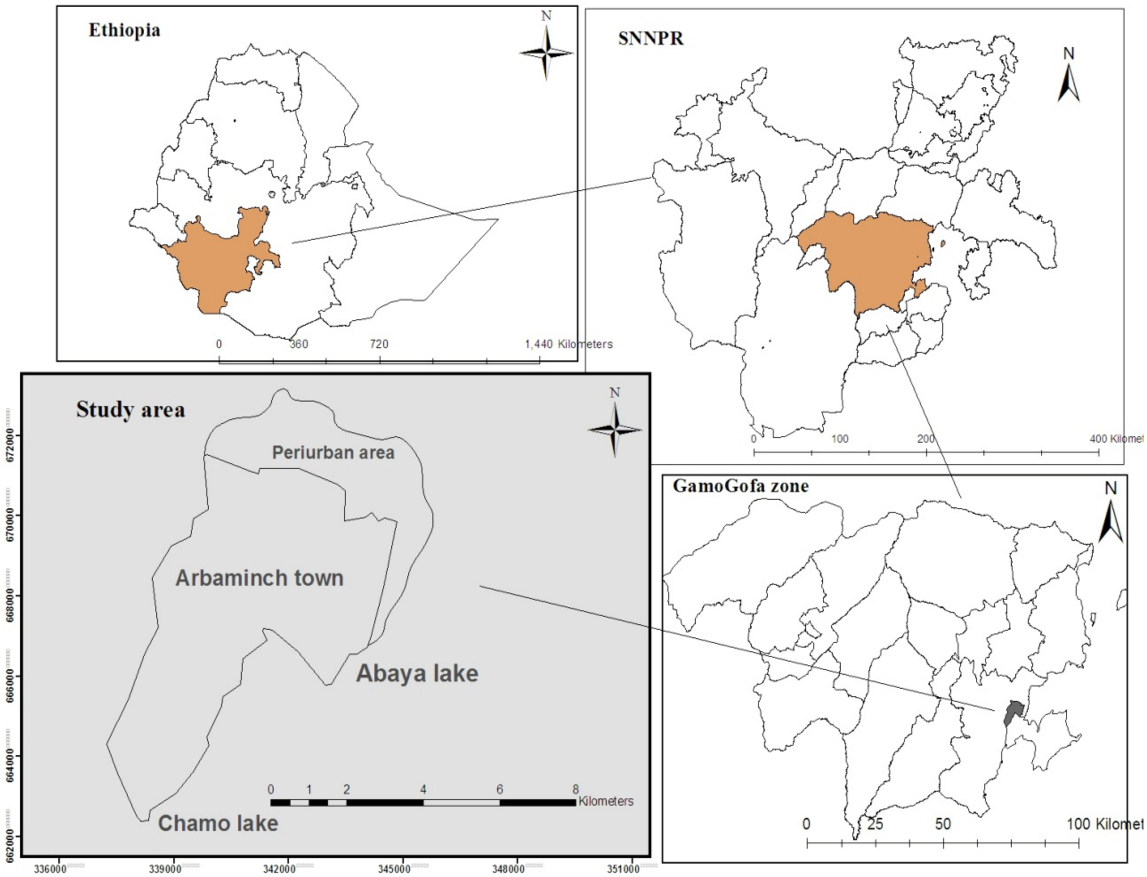
3. METHODOLOGY

3.1. Description of the Study Area

3.1.1. Physical Characteristics

Arba-Minch, which is the capital of Gamo-Gofa zone, is one of the largest towns in Southern Nations, Nationalities, and Peoples Region (SNNPR). It is located at 505 kms south of the capital, Addis Ababa and at 275 kms from the regional capital, *Hawassa*. It lies astronomically between 06°05′N latitude and 37°38′E longi tude. It was founded in 1962 with initial population of less than 2000 and 150 smaller houses scattered around covering an area of less than 2 square kilometers when the seat of Gamo-Gofa province changed from *Chencha* town to *Arba-Minch* and since then it has served as capital of *Gamo-Gofa* Zone (Arba-Minch Town Administration Office 2014). The word "*Arba-Minch*" is an Amharic compound word in which '*Arba*' means forty and '*Minch*' means spring. This name is originated from the discovery of forty and more wonderful springs coming up naturally from the rock located in the attractive indigenous dense forest found nearby the town.

The study area is situated in the western side of the Great Rift Valley in between the two major rift valley lakes of *Abaya* and *Chamo* in the northeast and southeast, respectively. It is also bounded in the west and northwest by *Ganta* missives. It has a linear shape and elongated to the north where there is a growing peri-urban settlement. It consists of four settlements, *Secha* (the uptown, where almost all administrative offices are located), *Sikela* (the downtown, which is the business center of the city), *Limat* (which contains more of commercial farms) and *Kolla-shara* (the peri-urban area).



Source: Author, 2014

Figure 3.1: Location map of the study area

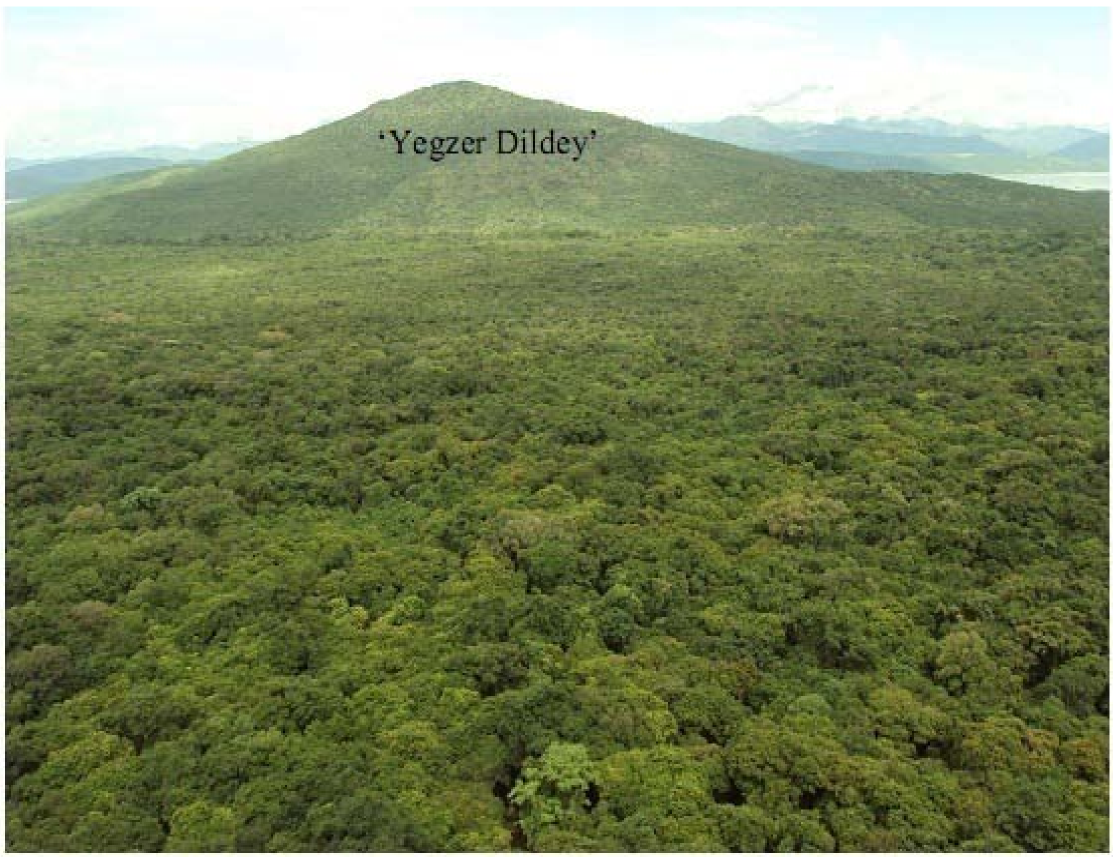
Currently, the town is getting expanded and developing mainly due to the increasing flow of national and international tourists in the area. The combination of its location and the associated geology have endowed the town and its surroundings with relatively abundant natural resources particularly water, fish and wild life. The area is a tourist destination as well as being the base for exploring the nearby natural scenery including the spectacular landscapes, *Chamo* and *Abaya* lakes, the hill in between, *Yegzer-Dildiy* (Bridges of God), the *Nech-Sar* (White Grass) park, the crocodile farm, the forty springs and the dense forest around the springs. All combined in a small area with excellent viewing opportunities attract considerable number of tourists from home and abroad. Moreover, it is the best route to arrive to the country's famous tourist destinations including traditional handicraft products and cultural landscape of *Dorze* and *Chencha* area (Gamo-Gofa Agriculture and Rural Development Office2014).

According to Arba-Minch Town Water Supply Service Office (2013), both Lakes *Abaya* and *Chamo*are important shallow lakes and home to one of the Ethiopian Rift Valley most remarkable aquatic ecosystems that support substantial fish populations, notably Nile perch which forms the basis of the local fishing industry. Besides the two lakes, there are a large number of streams descending the mountains that border the rift and join the lakes. Some of these are *Sago, Sile, Kulfo,* and *Hare* in the west and *Bilate*, and *Sermele* in the east of the lakes.

The study area has an altitude ranging from 1300 meters at the northern end to 1500meters above sea level at the southern end, and its climate is characterized by a relatively hot weather condition, with low and unevenly distributed rainfall pattern. *Secha* (the uptown) is slightly windy as it is situated on higher elevation whereas; *Sikela*, *Limat* and *Kola-shara* are hotter due to their lower elevations. The warmest months are from January to March and the cold season prevails from October to December. The maximum daily temperature ranges from 30^0c to 33^0c and minimum daily temperature from 12^0c to 17^0Cand the mean daily and annual temperatures of the study area are 29.7^0C and 25^oC, respectively (Arba-Minch Water Supply Service Office 2013).

Surveys such as that conducted by Aramde, F., Tsegaye B. and Pananjay K.(2012) have shown that the annual average rainfall ranges between 750 to 1100 mm, of which the substantial amounts falls in May, June, September and October. The area receives bimodal rainfall in the months of May and June (120-140mm per month) and a second rainy season in September and October (80 - 100mm per month). November, December, January, February and March are relatively dry months.

According to Gamo-Gofa Water and Energy Office report (2013), the geology of the area has been mapped as volcanic, composed of basalts and tuffs, and undifferentiated quaternary deposits. Regarding structures, distinctive step faulting characterizes the area with a north-south trend for the major structural features. The southern part of the town is situated over gently sloping land with minor undulations, while the northern part is situated on a relatively flat to gently sloping land. The high ground in the west drains to the town area through narrow and deep dry valleys and streams which form wide and meandering valleys when approaching the flat land.



Source: Arba-Minch Water Supply Service Office, 2013

Figure 3.2: The ridge between the lakes *Abaya* and *Chamo*, (*YegzeirDildey*)

According to Ethiopian Wildlife Conservation Authority (2014), the study area has about three thousand hectares of forest lands. The *Kulfo* riverine forest is located along the strip of *Kulfo* River and runs from the town to Lake *Chamo* bordering the ground forests in the east. The freshwater swamps at the mouth of the *Kulfo* River and in

Lake *Chamo* are dominated by tall waterside grasses and the small leguminous trees. Along the Lake shores typical shoreline vegetation of reeds and grasses are found.

Most of the vegetation of the area, however, is found in the valley below the southern part of the town (*Shecha*). This area, which is part of the *Nech-sar* park, exhibits a much denser bush land and a canopy forest which is the result of the presence of ground water emerging from the escarpment, as well as the permanent water supply provided by the *Kulfo* stream. *Nech-sar*'s landscape includes a variety of habitats ranging from savannah, dry bush and ground water forests. Part of the habitat in the park consists of the groundwater forest and shoreline of the lakes, but there are dry grassy plains, and most of the park is covered in thick bush land and the wooded valleys. The forest between the two lakes is dominated by tress which can grow up to 30 m tall (Aramde *et al.* 2012).

The forest area now covers an area of 3000ha of the surrounding area. The vegetation distribution in the area has been changed greatly over time because of high population pressure and subsequent deforestation. The forest cover has been depleted at ever increasing rate. Currently, due to an increasing demand for forest products, the available forest is under great threats. Indigenous tree species have been cleared over time in area around the town and along roads as farmers have extended their cultivated land.

Urban centers have long been dependent on rural hinterlands for their fuel. The increasing dependence of the urban centers on rural hinterlands has a much more serious environmental consequence which has resulted in growing fuel scarcity and higher firewood prices in urban centers, thereby undermining the livelihoods of the urban poor (Barnes *et al.* 2004). Similarly, Zenebe (2007) found that as urban areas develop, they depend on rural hinterlands for fuel, and this aggravates the problem of deforestation. Deforestation in contemporary times has resulted in growing fuel scarcity and higher firewood prices in urban centers.

Peri-urban households living in close proximity to the forest use fuel wood as the primary energy source for cooking. Much of the original vegetation has been cleared for fire wood. Over the years, this area has experienced intense deforestation due to the activities of wood fuel poachers in the town. Trees have been cut down in order to meet the ever increasing demand for wood fuels among residents of the town.

In their paper, Aramde *et al.* (2012) pointed out, on average 147 people have entered to the surrounding forests of the Arba–Minch town per day to collect different forest products. More number of male populations (53%) than females (47%) has been entering the forest to collect different forest products. Among these the highest number was observed for people who were collecting fuel wood amounting (58%), followed by grass collectors (10%).This has led to massive deforestation on the outskirts of the town, which in turn has resulted in land degradation and loss of biological diversity. Landscapes deprived of their natural vegetation cover are prone to soil erosion, which has negative impacts on the environment in general.

The excessive use of biomass fuels by residents has led to indiscriminate cutting of trees in the surrounding areas of the town. Nowadays, deforestation is worsened and most of the forest resources nearby the town have been exhausted due to excessive use of wood fuels (wood and charcoal) in the surrounding areas of the town. The utilization of forests around the town of Arba-Minch has effect on the flow of springs and ground water. The high rate of forest destruction poses a serious threat to many springs emanating from the ground and affect the current environmental problem whereby a climatic shift towards higher temperatures.

Aramde *et al.* (2012) pointed out the continuous deforestation in the ground forests resulted in the reduction of water flow from the forest. The forty springs discharged from this forest are in danger of water flow variability. As the vegetation is disturbed, the incoming rain fall causes erosion where the water move in the surface layer rather than percolating to the soil to increase the ground water storage. Because of this reason, the flora and fauna in the lakes and the surrounding areas are affected from pollution and extreme flooding during the rainy season.

Moreover, vegetation removal leads to several changes, including a decrease in photosynthetic rates and evapotranspiration where the decrease in evapotranspiration has an impact on precipitation, thus impacting stream flow and hydrological response

(Aramede*et al.* 2012). Flood occurrence in the southern part of the town in particular is very common in every rainy season. The surface runoff originated in the *Ganta* ridges and other hills surrounding the town has resulted in the formation of gullies and land degradation in general between the two parts of the town, *Secha and Sikella*. According to Gamo-Gofa Agriculture and Rural Development Office report (2014), twenty years ago, local trees covered the hills to the west of the town densely. There was no risk of flood and problem of erosion in the town and around because of vegetation cover but recently heavy rains caused the *Kulfo, Sile and Sego* rivers to burst their banks, which displaced farmers and unknown number of livestock were killed as well as an extensive area of crop fields destroyed.

With this fast rate of deforestation, the environment would reach to the point where it could not support the community and the wild animals, and as a result the town is facing livelihood problems. There have been very few efforts at reforestation and unless urgent action is taken by the government, the problem will persist progressively and the area will be losing its forests and the forty springs which are closely coexisting. If the current scenario continues, the local community would lose any benefit that it might obtain from the natural resources and would be in a great risk. The ultimate result will certainly be ecological deterioration, which will in turn affect the development of the town and the surrounding area. Therefore, an integrated forest and wildlife management with the involvement of all stakeholders may be a useful strategy to conserve the forest and associated resources in a sustainable way.

3.1.2. Demographic and Socio-economic Characteristics

The town together with its peri-urban area, has an area of 5,557hectares (55.57square kilometer) and an estimated total population of 104,107 with the average family size of 4.5 persons.Out of the total population, 51.81 percent are females while the rest 48.19 percent are males (Arba-Minch Town Administration Office 2014). The area is one of the fastest growing urban areas in the country with annual population growth rate of 4.8 percent and a doubling time of 15 years (CSA 2008). Administratively the town is divided into four sub-towns namely *Sikela*, *Secha, Abaya* and *Nech-sar*. Each sub-town encompasses three *kebele*s[1] except *Abaya* which has two *kebeles*.

Despite the hilly and sloppy topography of the town, the spatial expansion of the town was extremely fast due to the rapid flow of rural people from the surrounding highlands. At present the rapid population growth of the town is related to immigration of people from the surrounding highlands resulting in the development of squatter settlements in many parts of the town.

The town is not only one of the fast growing towns of the country but also it is favorable place to live and to make business and investment. According to Gamo-Gofa Labor and Social Affairs Office (2013), the job opportunities in the town can attract poor immigrants from every corner of the area. Most migrants are the dominant settlers in the peri-urban areas and their major source of household income relies on unskilled labor works. Their main visible activities are collecting and selling fuel wood, charcoal and timber, quarrying and transporting sand and stone, etc. Some of them are also engaged in fishing, retail trading and selling local brewed alcoholic drinks and prepared foods.

As zonal capital, the town happens to be both administrative and commercial center and has number of administrative offices and various nongovernmental organizations. So far, there are 95 manufacturing industries, 82 wholesale traders, 576 retail traders, 423 service premises, 6 fuel stations and 18 hotels with 800 bedrooms in the town (Arba-Minch Town Administration office 2014).There is a growth of secondary and tertiary sectors around the town that absorb significant man power. The town has more than 50 percent of economically active population of which 10 percent are unemployed. Of the total employees in both formal and informal sectors, 24.4 percent are temporary workers and 30 percent of the labor force in the town is public servant (Gamo-Gofa Labor and Social Affairs Office 2013).

[1]kebele: the smallest administrative unit under city or town administration

According to SNNPR Investment Office (2014), the town is one of the 22 reform towns selected in the region and has a structure plan prepared by the Regional Urban Organization Plan Preparation Core Process in 2008 and Local Development Plan for the core areas prepared by a private consultant in 2012. Although the town has witnessed expansion in space, there is inadequate supply of utilities and infrastructure to attract more tourists and investors. One of the major problems is lack of housing. Many of the residential units are poorly constructed and of inferior quality. Though nowadays houses are being constructed under condominium schemes, the number of houses constructed is not proportional to the population increase in the town.

According to the report of Gamo-Gofa Population Planning Office (2014), the rising town population and the increasing high cost of construction materials, has created a sizable gap between housing demand and supply. Within the last ten years period, the rate of change of population was 50.7 percent while the rate of house construction was only 47.2 percent. Recently the total number of housing units in the town was 15,042 while the number of households was 15,351. This makes 1.02 households per housing unit of the town.

The majority of houses are very poor in quality. Of the total houses, 12.5 percent have no direct access to water and electricity facilities. About 98 percent of urban households were living in a house made of mud floor. Majority of dwelling houses (66 percent) had no partition room and 9 percent of the households had no latrine. About 62.3 percent of households got the water from protected spring and piped water. Still more than one-third of households (33.7 percent) used drinking water from unprotected sources (CSA 2008).

The majority of the inhabitants practiced Orthodox Christianity; with 56.04 percent of the population reporting that belief, 38.47 percent were Protestants and 3.16 percent were Muslims. The five largest ethnic groups reported in the study area were *Gamo* (43.32%), *Gofa* (26.21%), *Amhara* (7.94%), *Welayita* (6.75%), and *Zayse* (6.02%) all other ethnic groups made up 5.92 percent of the population (Arba-Minch Town Administration Office 2014).

According to Gamo-Gofa Zone Agriculture and Rural Development Office (2014), due to the area's agro-climatic suitability and abundant irrigable land with fertile soil, it is considered to be the ideal site for the high potential and production of broad range of fruits and vegetables. The major perennial fruit tree is banana which is an important commercial commodity mainly produced for national market. As rainfall is unreliable and unpredictable throughout the season, it influences the cropping patterns of the farmers. Farmers in the peri-urban area use irrigation to produce banana throughout the year. The introduction of banana in the area has contributed to the development of new irrigation schemes. For years, farmers produced irrigated banana with gravity irrigation from the stream. The peri-urban area, which is situated in the lowland, is known for its irrigated banana farms as it receives water from small rivers that flow from the highlands.

Gamo-Gofa Zone Agriculture and Rural Development Office (2014) further indicated the area is affected by erratic rainfall. Flooding is a chronic problem during the rainy season and can periodically become severe when rainfall is heavy. During severe flooding, the entire food crop may be affected. Rain shortages are particularly damaging to non-irrigated crops. In the peri-urban non-irrigated lands, the inhabitants of the surrounding rift floor areas depend on rain-fed agriculture. Maize is the primary food crop and cotton is a primary cash crop and livestock production, including the fattening of oxen, is another important income source. Dry maize is harvested during the autumn (*meher)* season, beginning in September. Cotton is harvested from October to December and bananas are harvested every three months. Thus, this area is important for migratory laborers who come to work in the banana and cotton fields throughout the year.

The study area is one of the recently growing urban areas of the country which has been attracting people from the nearby rural areas. It is experiencing unbalanced situation between its rapid urban growth and the provision of household energy. The rate of energy demand increase appears to be outpacing the rate at which energy supply is being increased. Rising demand for commercially traded biomass fuels shows a growing pressure on local forests to meet cooking demands of the urban households. The high and direct dependence on wood fuels are contributing to unnecessary high level of surrounding indigenous forest resource removal which has resulted in growing shortage of biomass fuels and the accompanying rise of their prices. As a result of increased urban wood fuel demands there is a growing, large, illegal wood fuels trade that persists in the area. The other concern is there are sudden and frequent power cuts which can make electricity a very unreliable source of energy for use domestically and the users find it hard to predict its availability.

3.2. Research Design, Data Gathering and Analysis Methods

The methodological approach taken in this study is a mixed methodology based on sequential explanatory design where qualitative data collection methods are used following quantitative methods. Creswell (2003) demonstrated that the overall purpose of this design is that qualitative data helps explain or interpret the findings of a quantitative study. Because this design begins quantitatively, investigators typically place greater emphasis on the quantitative methods than the qualitative methods.

This study employed both qualitative and quantitative research methods to help address the questions raised in my research questions. The study places greater emphasis on the quantitative methods than the qualitative methods. For primary data acquisition, this research used a cross-sectional survey of urban and peri-urban households as the main methodological approach to collect information from selected households.

The research was conducted by the administering of a questionnaire that was balanced between open-ended and close-ended types of questions. This was done to obtain relevant data that allows flexibility to meet the intended objectives and, at the same time, not restricting respondents to the given options. The questionnaire was refined prior to fieldwork, through discussion and joint review with enumerators; pretesting of the questionnaire was undertaken with a few households before the main sample interviews. Any problems in the content of the questionnaires and other instruments were resolved during the pre-test.

The qualitative data collection that follows can be used to examine the results in more detail. The overall purpose of this design is that qualitative data helps explain or interpret the findings of a quantitative study. Qualitative data were collected using

Focus Group Discussions (FGD) and key informant interviews in order to gain insights into participants' opinions comprehensively and fill in the gap of information that was not covered by the survey. A total of five group discussions were arranged and six household heads were participated in each Focus Group Discussion (FGD) consisting of three male and three female members. A purposive sampling method was used to select the discussants from the target population. The researcher acted as moderator and guided the group and assisted by a note taker. Discussion was conducted in a common place and language that was convenient for all discussants and it lasted half an hour on average.

Furthermore, relevant information was gathered through discussion with key informants. For the in-depth interviews, four key informants were selected purposively from personnel working in different institutions such as Town's Administration Office, Ethiopian Electric Utility local branch, Zonal and Woreda Water and Energy Offices. The criteria for selecting these respondents were based on the position they held in their offices and the interviews were conducted in their respective offices. The key informant interviews with administrators and local experts were detrimental for gathering useful data with greater depth as well as to triangulate the finding of the quantitative study.Personal observation was also made in the sample households to supplement the other data collection tools. Secondary data were obtained from various published and unpublished documents of governmental and nongovernmental organization at different levels. Journals, books, newspapers, articles from internet were used as needed.

The questionnaires have been designed to capture both the actual and perceptional information from the households. The questions are basically aimed at gathering information about the household, head of the family and other family members, household energy use pattern and cooking behavior, the perception towards different fuels and end use technologies, magnitude of the expenditure made by the household in different type of energy, and the factors influencing fuel supply, accessibility, consumption, and health as well as environmental implications.

In the field work conducted, data on the consumption of energy resources for this study were gathered in terms of expenditure. Estimates of fuel consumption were made based on the respondents 'estimates of their monthly use. The respondents were asked to estimate the amount of fuel used on a monthly basis. Thus, the expenditure on household energy should be converted to the unit of energy resources consumed by a household.

Data were described using frequencies, percentages, mean, standard deviation, coefficient of variation and data results have been organized and presented in the form of tables, charts and graphs while to determine the relationship and to identify factors explaining household's end use energy consumption, Pearson correlation and linear regression model were used. In the analysis of data, the Pearson product moment correlation coefficient was used to determine the relationship between end-use energy consumption with independent variables.

Computing the Point-biserial correlation is equivalent to computing the Pearson correlation when one variable is dichotomous and the other is continuous (DeCoster2004) thus, Pearson Correlation has been run because the point-biserial correlation is simply a special case of Pearson's product-moment correlation(NCSF 2012 and Becketti1994). Linear regression analysis was used to determine and estimate the significance of the factors believed to influence household's use of fuels. Besides, to predict the goodness of fit of the regression model, multiple correlation coefficient (R), coefficient of determination (R2), and one way ANOVA F ratio were examined.

The advantage of using linear regression is that it utilizes the information on its entirety while binary models like logit and probit intended to estimate a dichotomous dependent variable. Binomial or binary logistic regression deals with situations in which the observed outcome for a dependent variable can take only two values. In 2004, Ahman and Chakrobartty published a paper in which they described using these models is necessary only to predict the probability of the score rather than the score itself. Logistic regression provides a method for modeling a binary response variable, which takes values 1 and 0, hence regression estimates less than 0 or greater than 1 are meaningless. Coefficients in these models are not very informative about the size of the impact of the explanatory variables.

The items of information were arranged and presented in the form of criterion and predictor variables. Information regarding consumption of energy in terms of expenditure and heat values is considered as criterion variable. All other variables were considered as predictors and are important in explaining household's choice of a particular fuel. The study identifies the different independent variables in order of their importance as predictors of urban domestic energy consumption with the help of beta coefficients. Coefficients are converted into standardized regression coefficients (beta) in order to allow us to better interpret and use it in forecasting.

3.3. Sampling Technique and Sample size

The target population for the study was the entire urban households residing within the town and *Kola-shara kebele*, which was taken to be one of the sample *kebeles* with the intention to represent peri-urban area. Two-stage sampling technique was applied to select the sample households. In the first stage, sample *kebeles* (the primary sampling units) were selected purposely from the study area and then sample households (the secondary sampling units) were selected from each *kebele* randomly using the lottery method.

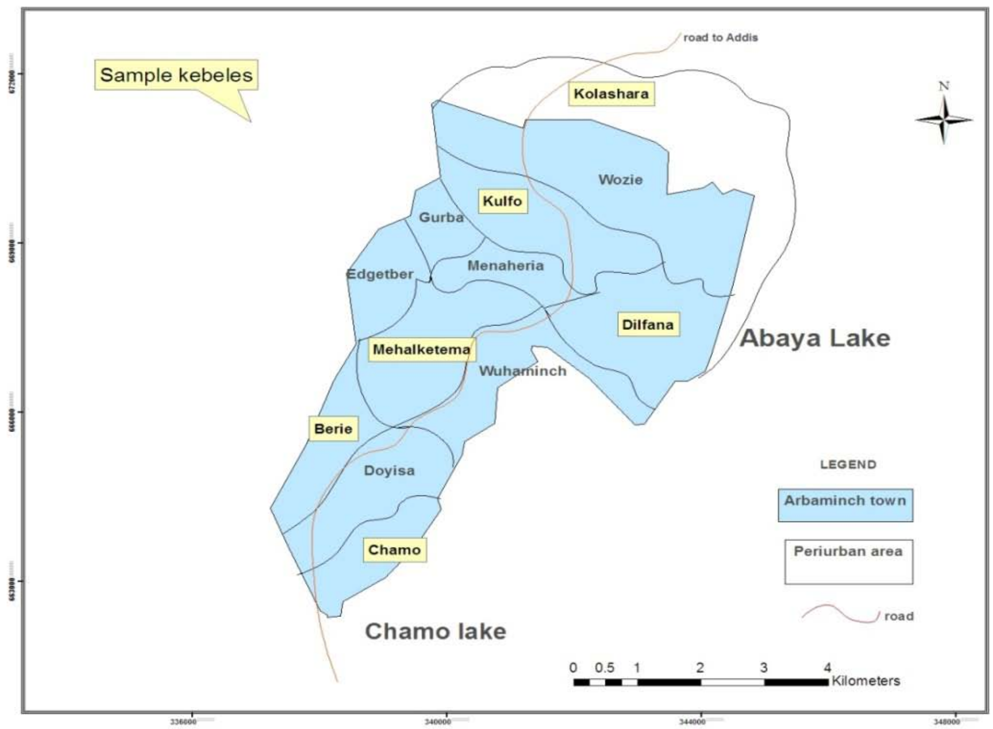
For sampling purposes, the *kebeles* were categorized into two strata based on the dominance of the type of residential housing units. After classifying the *kebeles* into two strata, three *kebeles* from each stratum were selected. Stratum one (*kebeles* with more shanty houses) has three *kebeles*, namely, *Birie, Kulfo* and *Kola-shara.* Stratum two (*kebeles* with more of better off housing units) has also three *kebeles*, namely, *Chamo, Dil-Fana* and *Mehal-Ketema*. After identifying the sample *kebeles*, sample households were selected using sex of the household head as the stratifying factor. A stratified sampling technique was used in selecting each household head in the *kebele* classified into sex. This was done to ensure sufficient presence of FHHs within the sample in view of the fact that women are amongst the most vulnerable groups to energy related problems. A total of 658 sample households (5% of MHHs *and* 15% of FHHs in each selected *kebele*) were selected randomly using the lottery method based on the list available in all *kebeles*.

The selection of each sampling unit (household) is conducted by applying random sampling method based on the list available in each *kebele*. The number of sample MHHs and FHHs foreach *kebele* is proportional to the respective total number of MHHs and FHHs in each sample *kebele* administration. Accordingly, the number of MHHs and FHHs taken as samples to this study comprises 383 and 275 respectively. The sample *kebeles* have a total population of 51,141 (49.12% of the population of the study area) and 9,505 households, of which MHHs and FHHs were 7,673 and 1,832, respectively. The details about sample towns and sample size determination have been provided in Table 3.1.

Table 3.1.Sample K*ebeles* and Household Size

Sample *Kebele*	**Household Size**			**Sample Household Size**		
	MHHs	**FHHs**	**Total**	**MHHs (5%)**	**FHHs(15%)**	**Total**
Kolla-Shara	1,328	135	1,463	66	20	86
Kulfo	1,369	427	1,796	68	64	132
Bire	1,394	318	1,712	70	48	118
Mehal-Ketema	1,040	306	1,346	52	46	98
Dil-Fana	1,246	225	1,471	62	34	96
Chamo	1,296	421	1,717	65	63	128
Total	7,673	1,832	9,505	383	275	658

Source: Arba-Minch Town Administration Office and Field survey, 2014



Source: Author, 2014

Figure 3.3: Map Showing the Location of Sample *Kebeles*

Based on the research plan, questionnaires were administered to the 658households. All participants, who provide valid responses, were drawn from each initial sampling unit. Out of which 9 households were not interested to give any information and during the process of cleaning the data, 17 questionnaires were incomplete and rendered invalid due to one or more key variables missing and were discarded. However, in such case, the next household head was included in the study in order to substitute the household which was with incomplete or invalid responses.

The head of the household responded for the interview. If the head was not available in the house during the visit, proxy respondents such as wives or elder children or relatives in the house were approached. Of all participants, 573 (87%) were heads of the household and the rest 85 (13%) were either wives of the household head or elder children or relatives in the house.

Ethical approval was obtained from respondents before conducting the field survey. The informed consent of the interviewees was sought in each case before being interviewed. After getting the consent of the interviewer, a semi-structured interview was conducted as per the objectives of the study. When conducting the research, participants were briefed about the objective of the study. Respondents' participation in the study was voluntary and each respondent was asked to give verbal consent to participate and those who were not willing to take part in the interviews replaced by others, the next household head was included in the study.

CHAPTER FOUR

4. HOUSEHOLDS' ENERGY CONSUMPTION PATTERNS

The first section presents the role of individual energy resource in the gross and end-use energy consumption. Then, households' fuel choice and adaptation of stoves in the end-use energy consumption will be discussed in the forthcoming section.

4.1. Households' Input (Gross) and End-use (Useful) Energy Consumption

This part discusses households' total input energy consumption and the amount of energy effectively utilized. The analysis of the data on patterns of energy consumption can be expressed either in terms of expenditure (ETB) or as the amount of energy consumed in terms of heat value of energy (mega-joules). The amount of energy consumed from each specific energy source can be estimated by converting its expenditure into heat value. Therefore, for conversion mechanism, total expenditure of each household on fuels is multiplied by the constant to get the heat value consumed by a household.

4.1.1. Households' Input (Gross) Energy Utilization

Biomass fuel, which consists of fuel wood, charcoal, sawdust, dung and crop residues, constitutes the highest share of the total household energy consumption. The most important of all the domestic biomass energy resources is fuel wood. Of the 658 sample households who completed and responded to the questionnaire, almost three fourth of the participants (75.38%) use fuel wood and a minority of participants (24.6%) indicated that they are not using the fuel wood for household purposes. Fuel wood is, therefore, vital sources of domestic energy in the study area besides the need for construction and household furniture.

With regard to the availability of fuel wood, 72.18 percent of sample households obtain it by purchasing. Fuel wood sellers are both male and female vendors who carry the fuel wood by their heads and backs, respectively. Households buy mainly of stems from male-vendors and twigs from female vendors. 12.10 percent of the households bought fuel wood from the local market and 3.43 percent of the households collect by their own. The rest 12.3 percent go for buying and collecting. Over half of those surveyed households (57.40%) are able to obtain regular supplies within one km of their residence. The frequency of purchase generally higher among low-income households, they often purchase fuel wood more than once in a month. Especially the urban poor, the purchase is more likely per week as they only afford to buy in small amounts. Location of households has direct impact on the access to collect fuel wood, i.e. the nearer the *kebele*is to the periphery; the more the fuel wood is collected.

Fuel wood consumption is often measured in head loads. Enumerators would need to weight a typical head load. Results from questionnaire surveys show that most households in the area consume between one and five bundles of wood fuel per month. Each bundle of wood fuel ranges in weight from 15 to 30 kg. Although fuel wood are usually sold in bundles along the highway with no actual weight measurements, human loads of better quantity of fuel wood are purchased at the outskirt of the town when these vendors are on their way towards the center.

In the field work conducted, the price of fuel wood ranged from 50 ETB per 25kg (2 ETB per kg) in peri-urban area to 80 ETB per 25kg (3.20 ETB per kg) in the town. Fuel wood vendors in the form of human load serve almost all sample households at an average price of 2.60 ETB for one kg of fuel wood. That means a household buys 0.38 kg for one ETB. One kg of fuel wood provides heat value of 15.072MJ[2]. Therefore, a household gets 5.73 MJ (15.07 x 0.38) gross heat value of fuel wood for one ETB (annex 1). This constant is important to convert household expenditure on fuel wood into gross heat value (MJ). For the rest of energy sources, the constants were manipulated in the same way.

Charcoal is another important source of domestic energy in the area. Out of the total sample households, the majority (86.02%) uses charcoal and only a small number of the respondents (13.98%) are non-users. Almost all charcoal is produced and traded by the informal actors. Nearly 90 percent of sample households generally purchase charcoal by the sack from charcoal vendors who deliver this fuel directly to them.

[2]It has been reported by UNDP (2009) cited in MoWE (2011)

About 4.32 percent obtained from retails and the rest 6.43 percent got from both market and vendors. Sacks of charcoal are offered for sale from charcoal vendors in almost all corners of the town. Sacks of charcoal typically weigh 25- 35 kg each.

Charcoal is sold at about 70 ETB per 30 kg sack of charcoal in peri-urban area (2.33 ETB /kg)while the price of 30 kg sack of charcoal is 120 ETB in the town (4.00 ETB /kg). The average price of a kilogram of charcoal was 3.17 ETB. One kilogram of charcoal provides heat value of 29.73MJ. So for one ETB a household could get 9.51MJ (29.73 x 0.32) heat value of charcoal (annex 1).

In the case of sawdust, 5.02 percent of the sample households use this resource. Of the total users, only 1.22 percent got sawdust for free and the rest users normally buy the fuel from sawmill. The average price of sawdust was 5 ETB per kg. Thus, a household bought 0.20 kg of sawdust for one ETB. One kilogram of this fuel delivers 16.75MJ heat value of sawdust. So a household could get 3.35MJ (0.20 x 16.75) heat value of sawdust for the expenditure of one ETB on sawdust (annex 1).

In order to get the average price of all the biomass fuels, first the number and the proportion of each fuel users were identified, secondly the price of each biomass fuel was multiplied by corresponding proportion of consumers, and thirdly, the products were summed up to get the average price of all biomass fuels (2.73 ETB) (Table 4.1).

Table 4.1. Cost and Kilogram Share of Each Biomass Fuel

Biomass Fuel Type	Number of Users	Proportion of Users	Price of Fuel per kg (ETB)	Cost Share of the Fuel (ETB)
Fuel wood	496	0.42	2.60	1.09
Charcoal	566	0.47	3.17	1.49
Sawdust	33	0.03	5.00	0.15
Dung-cake	96	0.08	0.00	0.00
Total	1191	1.00		2.73

Source: Field survey, 2014

All households in the survey were asked their opinions about the ease of access to an electricity connection. The majority of respondents perceived electricity as readily available and the majority of those who responded to this item felt that access to electricity is not considered as a problem. The survey indicates that almost the entire sample dwelling units in the study area had access to electricity supply. The majority of sample housing units (85.56%) got their electricity directly from local Ethiopian Electricity Utility (EEU), Arba-Minch Branch through the power grid connected. While 14.44 percent of the total sample households did not source electricity directly from EEU rather they share electricity with neighbors by making use of an extension cord.

All respondents with no electric meter expressed a willingness to obtain for a metered connection through legal supply rather than relying on illegal connections. Households using extension cords mentioned a number of disadvantages. Many complained that the power supply was unreliable (37% of responses). Owning of electric meter individually has been given consideration as an indicator of smooth electric utilization. Overall, these results indicate that sample households benefit more from owning electric meters compared to households who obtain electricity by illegal connection.

Those who do not have the meter and make illegal grid-connections were asked to suggest reasons why they could not own for themselves. Out of the total ninety five sample households who do not own electric meter, over half of them (56.24%) reported that it is due to shortage of money, while a quarter of sample households (24.91%) who fail to have own electric meters said that it is due to bureaucratic problem; others (18.75%) stated due to living in a rented houses. Likewise, key informant from EEU, Arba-Minch Branch, holds the view that the main barrier to get own electric meter was budget constraint, he further mentioned that access to an electricity connection is also difficult for those households living in areas which are not approved for settlement.

The price of electricity was based on fixed rate of payment for electricity consumed. The payment rates of electricity vary in slabs of the total amount of electricity consumed. The rate is a pricing structure that charges poor customers, who usually do not use much electricity (up to 50 kWh/month), a lower rate than higher income customers, who typically use more electricity. The monthly rate of payment per kWh varies from 0.273 ETB if the electric consumption was 50 kWh and less to 0.69 ETB for 501 kWh and above. That is, for example, if the total electric energy consumed is 100kWh, the first 50kWh is rated at about 27 cents per kWh and the second 50kWh is rated at about 36 cents per kWh (EEU 2013) (annex 2).

As Table 4.2 shows the average price of electricity paid by surveyed households was 0.389 ETB per kWh. Since 0.389 ETB was equivalent to one kWh, one ETB was equivalent to 2.56kWh. Thus, a household bought 2.56kWh of electricity for one ETB. One kWh of electricity is equivalent to 3.6MJ[3] of energy. Therefore, for one ETB, a household buys heat value of 9.22MJ (2.56 x 3.6) (annex 1). However, a household is not only paying for the electricity consumed, but households should also pay additional money for the rent of the electric meter, which is included in each slab of payment. For the sample households, electric meter rent varies from one ETB for 435 meters to 2.00ETB for 222 meters and one meter is for free. The total meter rent for the sample is 879.00ETB. Each household has to share electric meter service charge. The average electric service charge for the sample household was 1.34 ETB per month

[3]It has been reported by UNDP (2009) cited in MoWE (2011)

(879.00ETB /657) (annex 3). Therefore, household’s expenditure on electricity (Exp) was made less by 1.34ETB. Thus, the constant (Exp - 1.34) (9.22MJ) was used to convert the expenditure on electricity into MJ of gross energy consumption.

Ethiopian Electric Utility, Arba-Minch Branch, usually generates bills based on estimated rates than actual power consumption. Therefore, even though electricity supply may be erratic and consumers try to conserve energy by turning off their appliances when not in use, their bills stay the same. Out of the total 563 sample households who own electric meter, just nearly half (49.20 %) reported that they pay between 51.00 ETB and 100.00 ETB per month, 20.07 percent of respondents pay less than 50.00 ETB per month, and 29.66 percent of respondents pay as much as between 101.00 ETB and 200.00 ETB per month. While a small number of respondents (0.89%) pay 201.00 ETB and above per month. Only one household informant (0.18%) reported that he has got electricity from local EEU branch for free.

Table 4.2. Average Price of Electricity per kWh

Rate of Payment ETB/kWh	Monthly Electricity Expenditure (ETB)	Number of Users	Proportion of Users	Average Price (ETB)
0.00	Free	1	0.002	0.000
0.27	Less than 50	113	0.201	0.056
0.36	51-100	277	0.492	0.178
0.50	101- 200	167	0.297	0.149
0.55	201- 300	5	0.009	0.006
Total		**563**	**1.000**	**0.389**

Source: Ethiopian Electric Utility, Arba-Minch Branch, 2013 and Field survey, 2014

As far as kerosene is concerned, 25.08 percent of sample households utilize it for cooking. Out of these users, about 82.5 percent are able to purchase this fuel within one kilometer of their residence. Only 17.5 percent of households have to buy kerosene within a distance of more than one kilometer of their residence. Almost all kerosene users buy a liter of kerosene by 15.00 ETB from petrol station. Thus, 0.07 liter of kerosene was obtained for one ETB. One liter of kerosene delivers 33.62MJ[4] of heat value. Therefore, 0.07 liter of kerosene delivered 2.35MJ (0.07 x 33.62) of heat value (annex 1). In the case of other conventional fuels, the price of a piece of candle was 3 ETB. A household bought 1/3rd (0.33) of a piece for one ETB. One piece of candle delivers 1.88MJ of heat energy. Therefore, a household could get energy value of 0.62MJ (0.33x 1.88) for the expenditure of one ETB on candle (annex 1). The price of a piece of dry cell battery was 5.00 ETB. One piece of dry cell battery has an energy value of 0.0096MJ. Thus, a household can get an energy value of 0.00192MJ (0.0096 x 0.2) from using dry cell battery that costs one ETB (annex 1).

As it can be seen from the data in Table 4.3., the average monthly gross household expenditure on all sources of energy is 290.14 ETB, of which biomass fuel makes up the largest share (60.07%) while conventional fuel accounts 39.93 percent of the total domestic energy consumed in terms of energy expenditure. Households spend more than half of their gross energy expenditure on electricity and charcoal. On an average, households spend 31.69 percent of their gross energy expenditure for electricity, 31.40 percent for charcoal and 28.15 percent for fuel wood. The expenditure on kerosene is a mere 4.22 percent. The ratio of the average household fuel expenditure (290.14 ETB) to the average income of the household (2,315.09 ETB) was 12.53 percent. The ratio of the average household expenditure on biomass fuels (174.29 ETB) and conventional fuels (115.85 ETB) to the average income of the household (2,315.09 ETB) was 7.53 percent and 5.00 percent, respectively.

[4]It has been reported by UNDP (2009) cited in MoWE (2011)

Table 4.3. Mean Monthly Expenditure Share of Each Fuel Item (in ETB and %)

Fuel Type		Energy Expenditure			
		Per household		Per capita	
		ETB	%	ETB	%
Biomass fuels	Fuel wood	81.68	28.15	18.78	27.56
	Charcoal	91.11	31.40	21.33	31.30
	Sawdust	1.50	0.52	0.32	0.47
	Total	174.29	60.07	40. 43	59.33
Conventional fuels	Electricity	91.95	31.69	21.96	32.22
	Kerosene	12.25	4.22	2.97	4.36
	Candle	9.59	3.31	2.30	3.37
	Dry cell battery	2.05	0.71	0.49	0.72
	Total	115.85	39.93	27.72	40.67
	Grand total	**290.14**	**100**	**68.15**	**100**

Source: Field survey, 2014

The average monthly household and per capita gross consumption of biomass fuels in kilograms is presented in Table 4.4.The main source of energy type used by ninety six percent of the householders for cooking activities is largely from biomass fuels. Among the biomass energy resources, wood fuels (fuel wood and charcoal) are by far the most used cooking fuels for a large majority of urban and peri-urban residents in spite of the growing scarcity and price of these resources.

The average monthly gross biomass consumption per household was 62.19 kg while mean monthly per capita gross consumption of biomass fuels was 14.37kg. This suggests that biomass fuels consuming households used about 2.07 kg of biomass fuels per day. Mean monthly fuel wood and charcoal consumed by the household was 31.04kg and 29.16kg for baking and cooking purposes. This is equivalent to 7.14kg and 6.82kg per capita, respectively. Households use on average 1.69kg of cow dung and 0.30 kg of sawdust per month. It was also calculated that per capita dung and sawdust consumption was 0.35kg and 0.06 kg respectively.

Table 4.4. Share of Mean Monthly Household and Per capita Gross Consumption of Biomass Fuels (in kg and %)

Type of Fuel Consumption		**Fuel wood**	**Charcoal**	**Sawdust**	**Dung-cake**	**Total**
Per household	kg	31.04	29.16	0.30	1.69	62.19
	%	49.91	46.89	0.48	2.72	100.00
Per capita	kg	7.14	6.82	0.06	0.35	14.37
	%	49.69	47.46	0.42	2.44	100.00

Source: Field survey, 2014

Table 4.5 presents the average monthly household and per capita gross consumption of conventional fuels in terms of the respective unit of energy measurements. The average monthly gross electricity consumed by a household was 235.83 kWh. This suggests that electricity consuming household utilized about 7.83kWh of electricity per day. The average monthly gross kerosene consumed by a household was about 0.86 liters, whereas mean monthly gross per capita consumption was 56.29 kWh for electricity and 0.21 liter for kerosene. As to monthly domestic electric consumption, nearly a quarter (24.43%) of the domestic customers consumes a maximum of 25 kWh, while 75.57 percent consume below 100 kWh per month.

During the field visit, it was found that majority of peri-urban households used fuel wood for cooking although a few households had installed the biogas plant recently. The key informant, from the Zonal Water and Energy Office, indoor air quality of peri-urban homes significantly improved as a result of employing biogas technology instead of burning fuel wood and dung cakes. The type of input regularly used for generating biogas is dung from oxen, cows and calves which is usually obtained from own house and lands where animals are kept more in confined spaces. Over half of those surveyed (56.20%) indicated that the input from their cattle dung is not enough to feed the bio-digester, hence they collect additional dung from grazing areas and it is fed irregularly to the plant.

Table 4.5. Mean Monthly Gross Consumption of Conventional Fuels by Unit of Energy Measurement

Type of Fuel Consumption	**Kerosene (lt)**	**Electricity (kWh)**	**Biogas ($m^{3)}$**	**Candle (piece)**	**Dry cell (piece)**
Per household	0.86	235.83	0.16	3.17	0.41
Per capita	0.21	56.29	0.03	0.76	0.10

Source: Field survey, 2014

According to the survey findings, those who have small number of cattle use biogas to cook foods rarely and give light only for one house due to shortage of dung. Average household biogas consumption is only 0.16 m^3 (Table 4.5). All of the respondents, during household interviews, and most of the participants of the FGDs and PRAs with functional biogas plants informed that women who spend most of the time at home, also get health benefits more than men because the technology avoided the smoke and household wastes related health problems.

Although the study (from the data collected) considered all possible fuel types and categories, none of the sample households used LPG. Thus, the empirical analysis focused on the following fuels: firewood, charcoal, dung cake, saw dust, kerosene, electricity, biogas, dry cell battery and candle.

Table 4.6. Average Heat Value of Biomass Fuel per kilogram (MJ)

Biomass fuel Type	**Number of users**	**Proportion of users**	**Energy content (MJ)**	**Share of heat value(MJ)**
Fuel wood	496	0.42	15.07	6.32
Charcoal	566	0.47	29.73	13.97
Sawdust	33	0.03	16.75	0.50
Dung-cakes	96	0.08	12.14	0.97
Total	**1,191**[5]	**1.00**		**23.05**

Source: Field survey, 2014

Considering the price of each energy type, expenditure made on source of fuel was converted to gross energy in terms of heat value (MJ). Accordingly, on average, fuel wood, charcoal, sawdust, electricity, kerosene, candle and dry cell battery have got a gross heat value of 5.73, 9.51, 3.35, (Exp - 1.34)(9.22), 2.35, 0.62 and 0.002, respectively (annex 1). As far as dung cake and biogas are concerned, households usually procure for free from own cattle near the house throughout the year. Unlike other fuels, the study here used the amount of heat energy per their respective units of energy rather than their prices as reference to find out their gross heat values (MJ). It has been reported by UNDP (2009) cited in MoWE (2011) that one kilogram of dung cake and one cubic meter of biogas can provide heat values of 14.50MJ and 22.80MJ, respectively (annex 1). Therefore, these constants by themselves are also important to convert household consumption into gross energy heat value.

[5]It is due to multiple responses, total responses are 1,191.

From Table 4.6, it can be seen that the average heat value for a kilogram of biomass fuel is 23.05MJ. To calculate the average heat value of biomass fuels, first, energy content of each biomass fuel is multiplied by corresponding proportion of consumers, and then the products are summed up to get the average heat value per a kilogram of biomass fuel (23.05MJ).

Based on the gross energy heat value constants, the mean monthly household gross energy consumption was estimated to be 2,251.96MJ. Out of this, consumption of biomass fuels accounts the highest proportion (60.51%) while the rest (39.49 %) monthly household gross energy consumption was from conventional fuels. On an average, 38.48 percent of household gross energy consumption was from charcoal, 37.72 percent was from electricity, 20.78 percent was from fuel wood and 1.28 percent was from kerosene. With regards to the average per capita gross energy consumption, the biomass fuels have still greatest share (59.93%), with an average monthly per capita gross energy consumption of 316.61MJ. While the rest (40.08 %) monthly per capita gross energy consumption was from conventional fuels. Monthly average per capita gross energy consumption was 202.81MJ for charcoal, 202.72MJ for electricity and 107.62MJ for fuel wood in terms of heat value (Table 4.7).

Table 4.7. Share of Mean Monthly Gross Energy Consumption (in MJ and %) by Fuel Type

Fuel type		Gross Energy Consumption			
		Per household		Per capita	
		MJ	%	MJ	%
Biomass fuel	Fuel wood	468.02	20.78	107.62	20.37
	Charcoal	866.50	38.48	202.81	38.39
	Sawdust	5.04	0.22	1.07	0.20
	Dung cake	24.57	1.09	5.11	0.97
	Total	1,364.13	60.51	316.61	59.93
Conventional fuel	Electricity	849.34	37.72	202.72	38.37
	Kerosene	28.80	1.28	6.97	1.32
	Biogas	3.74	0.17	0.61	0.12
	Candle	5.95	0.26	1.43	0.27
	Dry cell battery	0.004	0.05	0.001	0.01
	Total	887.83	39.49	211.73	40.08
	Grand Total	**2,251.96**	**100**	**528.34**	**100**

Source: Field survey, 2014

4.1.2. Households' End-Use (Useful) Energy utilization

From the previous discussion, it can be seen that the consumption of fuels was estimated in the total input household energy consumption regardless of the efficiency of fuels and appliances used. According to Barnes *et al.* (2004) the amount of heat that is burned for cooking is called the "input energy" and the amount that is actually absorbed by pots, pans, and or other cooking vessels is called "useful" or "delivered" energy. The difference is waste heat that escapes around the sides of the pan. Drexler (2004) noted that although energy input is essential in most work processes, it is not a true measure of the benefit to households from energy consumption. What becomes important to the consumers is not the gross energy consumed but how much end-use energy do the households consumed which is the energy that is adjusted for the level of efficiency at which a given resource of energy is used.

The efficiency level of energy source determines the amount of useful energy a household can obtain. The amount of useful energy differs from one type of fuel to another depending upon the quality of fuels. In a study conducted by Clancy *et al.* (2003), it was shown that the efficiency of a fuel is measured by the amount of energy used for cooking compared with that which escapes from the stove without actually heating the food. For example, fuel wood used to function at the efficiency level of 10 percent.

Open wood fires commonly used for household cooking have approximately 10 percent conversion efficiency, and are wasteful of energy during periods when low heat is required since there is no control of the oxygen supply (Samson, R., Stohl, D., Elpano, A, and De Maio, A. 2006). Fuel wood used to function at the efficiency level of 10 percent means that out of a gross energy produced by burning fuel wood, only 10 percent is effectively utilized; the rest 90 percent is wasted away. On the other hand, modern energy sources such as kerosene, biogas, candle and electricity used to function at better efficiency levels of more than 50 percent (Table 4.8).

Table 4.8. Mean Monthly End-use Energy Consumption (in MJ and %) by Fuel Type

Fuel type		Fuel efficiency (%)	**End-use Energy Consumption**			
			Per household		**Per capita**	
			MJ	%	MJ	%
Biomass fuel	Fuel wood	10	46.80	5.33	10.76	5.16
	Charcoal	20	173.30	19.72	40.56	19.47
	Sawdust	16	0.81	0.09	0.17	0.08
	Dung	12	2.95	0.34	0.61	0.29
	Total		222.92	25.37	51.90	24.93
Conventional fuel	Electricity	75	637.00	72.48	152.04	72.97
	Kerosene	50	14.40	1.64	3.49	1.67
	Biogas	55	1.87	0.21	0.31	0.15
	Candle	65	3.87	0.44	0.93	0.45
	Dry cell battery	75	0.003		0.0007	
	Total		655.91	74.63	156.46	75.07
	Grand total		**878.83**	**100**	**208.36**	**100**

Source: Field survey, 2014

In order to convert expenditures on various resources of energy in to end-use energy in terms of heat value, first the constant that is already obtained for gross heat value of fuel is multiplied by the efficiency level at which the source of energy is utilized. For instance, the efficiency level of fuel wood (0.10) was multiplied by the constant (5.73), which is gross heat value of fuel wood. Then the product obtained (0.573) will be another constant used to convert expenditure on fuel wood into heat value of end-use energy. For the rest energy sources, the constants were manipulated in the same way. Thus, constants to obtain end-use heat value for charcoal, dung cake, sawdust, electricity, kerosene, biogas, candle and dry cell battery are 1.902, 1.74, 0.536, (Exp – 1.34)(6.915), 1.175, 11.40, 0.403 and 0.0014, respectively. These are constants to convert expenditures on various resources of energy in to end-use energy in terms of heat value (MJ) (annex 1).

As can be seen from Table 4.8, the average monthly household and per capita end-use energy consumption in terms of heat value are 878.83MJ and 208.36 MJ, respectively. Out of the heat value of gross energy a household received (2,251.96 MJ), the average monthly amount of end-use energy consumed was 39.03 percent. In terms of end-use energy consumed, conventional fuels occupy the leading position (74.63%) while biomass fuels provide low energy heat values (25.37%) due to low efficiency of utilization. In spite of the fact that biomass fuel would remain important household fuel for majority of the households, the share of electricity is also significant in the consumption of end-use domestic energy in the town. Among all energy sources, the proportion of electricity in terms of heat value of end-use energy is the highest (72.48%) followed by charcoal (19.72%) and fuel wood (5.33%).

The average monthly per capita end-use biomass and conventional fuels energy consumption were 51.90MJ (24.93%) and 156.46MJ (75.07%), respectively. Out of the heat value of per capita gross energy received (528.34MJ), the average monthly per capita end-use energy consumed was 39.44 percent. The average monthly per capita end-use energy consumed in terms of heat value varies from highest figure (152.04 MJ) for consumption of electricity to almost nil (0.0007 MJ) for consumption of dry cells. This implies that even though the end-use of conventional sources of energy for domestic purpose is still very low in the study area as a whole, the consumption of electricity shows a drastic growth to meet the largest share of the total domestic energy requirement while charcoal and fuel wood are by far the most used biomass source of energy.

The total energy converted into end-use depends not only on the type of fuel used but also on the type of device or appliances used. A household's end-use energy is the aggregate of all physical sources after their end-use efficiencies are taken into account. The end-use energy that a household consumes is always less than the total energy that is available from all the physical sources that the household uses. The ratio of output energy to input energy gives a measure of the conversion efficiency of a particular piece of equipment. The efficiency of a given energy conversion process may be as high as 90 percent, but never 100 percent (Clancy *et al.* 2003 and Zenebe 2007).

When one form of energy is converted into another form for a particular purpose, not all the energy ends up where one would like. It all depends upon the type of device or appliances used. Rather, some energy is wasted or lost in the conversion process in the form of heat. The ratio of the useful energy output to the required input is what is called as the efficiency of the process. The higher the efficiency, the less is the loss of energy (Zenebe 2007).

Biomass fuels used in traditional stoves have much lower efficiency than the modern ones. Most of the energy embodied in the source is wasted due to inefficient cooking appliances used in the households (Barnes *et al.* 2010).Zenebe (2007) holds the view that the open hearth (three-stone stove) functions at a very low efficiency level (12%), that is when baking is carried out on a three stone fire, much of the energy content of the available energy source is wasted (88%). Barnes and Toman (2006) noted the typical efficiencies of woodstoves or open fires range from 10 to 15 percent, and charcoal stoves reach up to about 25 percent. In contrast, LPG and electric stoves have efficiencies of between 55 and 75 percent and Khandker *et al.* (2010) further demonstrated the end-use efficiency of kerosene for cooking (burned in a wick stove) is about 35 percent.

According to Abebe and Koch (2011) traditional metal charcoal stove and *Lakech*[6] stove, which is made from clay, sand and cement are used with efficiency levels of 20 percent and 40 percent, respectively. *Lakech* stove reduces 25 percent of charcoal consumption compared to the traditional metal charcoal stove. Whereas, *Mirt*[7], kerosene

[6]*Lakech*: better/ improved charcoal stove

and electric baking stoves can reach efficiencies of up to about 35 percent, 56 percent and 75 percent, respectively. The detail information on the cooking end-use energy consumption based on the efficiency of end-use equipment is shown in Table 4.9.

Table 4.9.Mean Monthly Baking and Cooking End-use Energy Consumption (in MJ) by Stove Efficiency Level

Fuel type	Stove used	Stove Efficiency level (%)	**Household End-use Energy (MJ)**	**Per capita End-use Energy (MJ)**
Fuel wood	Open hearth (three-stones) stove	12	49.64	11.06
	Mirt baking stove	35	19.03	5.40
Charcoal	Traditional metal stove	20	17.21	4.07
	Lakech stove	40	312.36	73.02
Sawdust	Open hearth (three-stones) stove	12	0.60	0.09
Dung cake	Open hearth (three-stone) stove	12	2.95	0.61
Kerosene	Kerosene stove	56	16.13	3.90
Electricity	Electric baking & cooking stoves	75	295.98	73.17
Biogas	Biogas cooker	55	0.45	0.07

Source: Field survey, 2014

[7] *Mirt*:best/improved *Injera* stove

In order to convert expenditure on fuel wood using open hearth (three-stones) stove into heat value of end-use energy, the efficiency level of open hearth (three-stones) stove(12%) was multiplied by the gross heat value constant of fuel wood (5.73), then the product obtained was 0.688 which is another constant used to find out the end-use of fuel wood consumption using open hearth (three-stones) stove. For the rest energy sources, the constant was manipulated in the same way. Therefore, the products for fuel wood using *Mirt* stove, charcoal using traditional (metal) stove and charcoal using *Lakech* are 2.005, 1.902 and 3.804, respectively. These values are derived from the efficiencies of stoves with which the fuels are typically burned for cooking.

Among fuel wood using households, those who utilize the improved baking appliance *(Mirt)* can consume end-use energy of 5.40MJ per person, while those who utilize open earth consume 11.06MJ. This implies that the majority households often lack the ability to optimize their consumption through improved technologies. A family has to purchase modern domestic baking appliances for the effective utilization of the available modern cooking fuels. Those who utilize *Lakech* and electric cooking stoves can consume higher end-use energy. The proportion of electricity in terms of heat value of end-use energy is the highest (73.17MJ) followed by charcoal (73.02MJ).

4.2. Households' Choice of Energy Sources and Energy Using Technologies

4.2.1. Household Function of Baking and Cooking

The most frequented cooking end-uses on daily basis, the main sources of energy the household frequently use; and types of stoves and kitchen characteristics for the most popular specific baking and cooking activities will be discussed in this section of the chapter.

As evident in Table 4.10, in almost all sample households (99.39%) *Injera*[8] baking is the most common energy consuming activity. Cooking local foods such as *Kurkufa and Fosossie*[9] is also other common household activity. They may be served along with

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[8]*Injera*: pan-cake like Ethiopian food made from "*teff*"

[9]*Kurkufa and Fossessie*: local foods made from maize or sorghum flour

Haleco. When households asked whether they prepare these local foods, 41.19% and 33.59% reported that they regularly cook and consume *Fosossie* and *Kurkufa*, respectively.

Of the various energy end uses, *Wot*[10] is frequently cooked in almost all households (97.72%). Making coffee is a very popular and it is a traditional hot drink for Ethiopians. Except for few persons, the majority of the households (92.25%) usually prepare coffee and many people believe that the coffee culture promotes interactions among neighbors. A small number of sampled households (3.43%) prepare the local nutritious drink, namely *Cheka*[11] using the leafy edibles. Furthermore, 5.47% and 1.98% of the surveyed households responded that they brew local alcoholic drinks, namely *Arek*i[12] and *Tella(Shameta)*[13], respectively (Table 4.10).

A question was also forwarded if the households bake *Injera* as an income generating activity. Only 2.75% of the households have responded that they bake *Injera* for commercial purpose. Considering the frequency of *Injera* baking as indicated in Table 4.11, more than half of *Injera* bakers (57.80 %) bake *Injera* at home three times a week and 34.86% twice a week and a minority (7.34%) bake *Injer*a once in every week.

[10]*Wot*: sauce for *injera*

[11]*Chakka*: a homemade alcoholic beverage

[12]*Arake*: local liquor

[13]*Tella(Shameta)*: Home- brewed alcohol

Table 4.10. Percentage Distribution of Survey Households by Baking and Cooking End-uses

Basic Energy End-Uses		Household Involved	Percentage of Responses	Percentage out of 658
Baking	*Injera*	654	20.60	99.39
Cooking	*Wot* (Stew)	643	20.25	97.72
Making Local Foods	*Kurkufa*	221	6.96	33.59
	Fossessie	271	8.54	41.19
	Haleco[14]	249	7.84	37.84
Making Local Drinks	*Areki*	36	1.13	5.47
	Cheka	22	0.69	3.43
	Tella/Shameta	13	0.41	1.98
Making Hot Drinks	Coffee	607	19.12	92.25
	Tea	459	14.47	69.76
Total		**3,175**[15]	100	

Source: Field survey, 2014

Out of the total local foods cookers, more than half of them (53.97%) cook local foods at home once in a week and nearly a quarter of sample households (23.18%) cook local foods two times a week. The rest 11.26 percent and 11.59 percent reported they cook local food only three times in a week and once in two weeks, respectively. Almost all

[14]*Halleco*: local foods made from leafy vegetables

[15]It isdue to multiple responses, totalresponses are 3,175.

local foods users explained that they do usually cook on weekends when most of the family members gather at home.

More than half of the respondents (55.83%) reported that they cook *Wot* once in a day; 29.08 percent twice a day, the rest, 15.08 percent cook three times in a day. Regarding the frequency of coffee making, it has been found that over half of the respondents (52.55%) make coffee once on daily basis, 26.69 percent twice a day and the remaining 9.72 percent, 6.92 percent and 4.12 percent prepare coffee trice in a day, once in a week and trice in a week, respectively (Table 4.11).

Table 4.11. Percentage Distribution of Survey Households by Frequency of Baking and Cooking

Energy End-uses	Once a day	Twice a day	Trice a day	Once a week	Twice a week	Trice a week	Once in two weeks	Once in three weeks
Baking *Injera*	-	-	-	7.34	34.86	57.80	-	-
Cooking *Wot*	55.83	29.08	15.08	-	-	-	-	-
Making Coffee	52.55	26.69	9.72	6.92		4.12	-	-
Making Tea	59.26	22.00	5.66	13.07	-	-	-	-
Making Local drinks	-	-	-	25.35	-	-	42.25	32.39
Cooking Local foods	-	-	-	53.97	23.18	11.26	11.59	-

Source: Field survey, 2014

The current fuel consumption pattern of the sample respondents based on the consumption of specific fuel users is presented in Table 4.12.As the data in the Table indicates the majority of households are dependent on biomass energy sources (fuel wood, sawdust and cow dung) for baking *Injera*. Fuel wood is the dominant source of baking energy; households occasionally use dung and sawdust as a supplementary source.

Fuel wood tends to be the primary baking fuel for 72.94 percent of *Injera* baking households, and is used on at least a supplemental basis by 14.01 percent households for the same purpose. 12.77 percent of sample households utilize dung for *Injera*baking. Despite the existence of large furniture factory in the town, sawdust is used only by 5.15 percent of sample urban households. On the other hand, over a quarter of the sampled households (27.06%) in the town use electricity to bake *Injera*.

For preparing local foods, fuel wood again remained the major form of energy. Nearly two third (62.48%) of local foods consuming households use fuelwood as the main source of fuel for local foods cooking while 25.44 percent, 20.56percent and 5.92 percent of these households use dung cakes, charcoal and biogas respectively. Moreover, fuel wood (48.08%) and charcoal (23.53%) are considered as secondary fuels for local foods making. Most people are used to eat such local foods cooked on a pot over an open fire. Fuel wood is the most used primary local foods cooking fuel. Most people prefer fuel wood to other fuel sources such as kerosene or charcoal for the cooking of local foods as they require longer cooking time and reported to be tasteful, and the fact that the burner surfaces in kerosene and charcoal stoves are too small to cook a large amount at once.

Charcoal is the most used and primary fuel for *Wot* cooking, accounting for 56.85percent while few households (2.52%) in peri-urban areas use biogas as a primary fuel for *Wot* preparation. Fuel wood (36.49%) and kerosene (31.08%) were considered secondary fuels for making *Wot.* Charcoal is also identified as the most important fuel source by 83.69 percent of the respondents who make coffee at home. Moreover, it is used on at least a secondary basis in 2.88 percent of the total coffee making households. Other fuel like kerosene (35.19%) is taken as main supplementary fuel. With regards to making tea, about half of the tea making households (53.03%) prepares tea using mainly of charcoal and 31.39 percent of the surveyed households also utilize kerosene as a primary fuel (Table 4.12).

Table 4.12. Percentage Distribution of Survey Households by Fuel Choice for Baking and Cooking End-uses

Energy end -uses	**Fuel Choice**	**Fuel Type used**					
		Fuel wood	Charcoal	Dung cake	Kerosene	Biogas	Electricity
***Injera* Baking**	Primary	72.94	-	-	-	-	27.06
	Secondary	14.01	-	12.77	-	-	11.46
Local Food Cooking	Primary	62.18	20.56	25.44	-	5.92	-
	Secondary	48.08	23.53	12.61	-	3.36	-
***Wot* Cooking**	Primary	9.92	56.85	-	23.94	2.52	6.77
	Secondary	36.49	19.59	3.72	31.08	1.35	7.77
Tea Making	Primary	0.65	53.03	-	31.39	12.81	12.12
	Secondary	22.03	22.37	-	29.49	-	26.10
Coffee Making	Primary	8.40	83.69	-	5.11	2.80	-
	Secondary	51.92	2.88	-	35.19	2.44	7.67

Source: Field survey, 2014

Even with high access to electricity, biomass still remains the primary energy for baking and cooking. The proportion of households using fuel wood for baking *Injera*, and cooking local foods as well as brew local alcoholic drinks is higher while charcoal and kerosene are by far most important types of cooking fuels used by two thirds of sample households. Charcoal is found to be the significant source of energy for cooking *Wot*, coffee and tea in both urban and peri-urban areas followed by kerosene. Though kerosene was second to charcoal, its use is less common as a primary cooking fuel. However, more people use it as a secondary fuel, mainly for fast cooking. The data indicate that 23.10 percent of households still use kerosene as a cooking fuel and 26.90 percent use electricity for domestic cooking purpose while in the case of biogas there are only 17 users within the sample households. The use of LPG for cooking is almost negligible.

Moreover, only 19.3 percent sample households used single source of energy for cooking while the proportion of sample households who depend on multiple energy options as main energy sources is 80.7 percent. Here it should be well emphasized that most of the sample households utilize more than one type of fuel for different types of fuel end-uses. Use of a mix of two fuels for cooking purposes is common in most of the households (Annex 4.). Households need a mix of commercial energy sources, including fuel wood, charcoal, kerosene and electricity to help manage their daily cooking activity. This is partly because they tend to use certain fuel energy sources for certain foods.

Biomass fuel is very important in the energy mix of all households interviewed. The majority of the households interviewed fall into the category that use both charcoal and fuel wood together. They were used as the main baking and cooking energy source in a considerable number of urban households (66.26%), while electricity and kerosene appear only in a limited category for the purpose of cooking. Even if the use of charcoal is always accompanied by fuel wood, to offset the supply problems linked to biomass fuels, about 18.69 percent of sample households have chosen to diversify their choices by combining charcoal and kerosene as their main energy source for cooking purpose. Kerosene was used for emergency cooking along with biomass fuels.

Charcoal is most preferred urban cooking fuel and is still very important in the energy mix of all households. The results show that majority of the households regardless of their economic status combine the use of charcoal with other source of energy in their household. Assessment of fuel end-use showed that roughly half of those surveyed households use charcoal as their primary fuel and many more use it in combination with kerosene, and/or electricity to satisfy some cooking needs. The survey revealed that a quarter of the sample households (25.84%) use charcoal and electricity, which is another most common cooking energy mix. For those households who use electricity as the main source of baking and cooking energy, they also use charcoal in significant amounts.

Peri-urban households using biogas for cooking also use fuel wood to supplement their cooking fuel requirement. As it could directly be observed during the survey, all of the bio-digesters of the surveyed peri-urban households were functional. Nearly 5 percent have been using the digester for less than 5 years. Only 2 percent are functioning for more than 5 years. The visible challenges of the biogas technology could also be noticed during the study. There is a substantial lack of knowledge among consumers concerning biogas. Local people were not made aware of the full potential of the plants. Peri-urban households could not fully rely on the biogas plant for meeting their energy needs as they still needed to use the fuel wood, agricultural residue and animal dung for baking their daily meals. Moreover, absence of skilled personnel at the villages that can maintain the damaged parts and the lack of accessories are the major reason to stop functioning of some plants. Therefore the challenge is how to facilitate a method for all communities to access biogas to improve peri-urban livelihoods.

Talking about this issue a woman in an interview mentioned that " *I feel sometimes uncomfortable with biogas technology and I do not want to abandon the traditional stoves as they are most comfortable with*". Another woman interviewee said that *"we cook with biogas, but if it goes wrong sometimes we do not know how to fix it. So we better continue to use the fuel wood along with the biogas."*

For the more rigorous analysis, the study looks into three categories of households according to the main fuel consumed for the purpose of baking and cooking. Energy consumers are grouped into three categories according to the main fuel used: those whose main fuel was only biomass fuels, only conventional fuels, and a mixture of biomass and conventional fuels. Those households who consume only biomass fuels are no switching households, those who consume only conventional fuels are complete switching households and those who use a mixture of biomass and conventional fuels are partial switching households. Switching from biomass to conventional fuels for cooking was difficult for more than half of the sample households (52.31%). Fuel switching is partial for 44.72 percent of the households while only a minority (2.97%) switches completely. This indicates no significant switching from wood fuels to conventional fuels had occurred in households' energy use.

The study results indicate that most households are more likely to consume multiple fuels. There is a tendency to use more wood fuels with limited conventional fuels for the purpose of baking and cooking. Thus, biomass fuel is the most important source of energy and remains to be dominant in all income urban households. This is an indication that there is a slow and partial energy transition prospect with regard to cooking fuels in the town.

Respondents were asked why conventional fuels (such as electricity) that are accessible to them are not being used for baking and cooking, they stated that the cost of electricity would be very expensive. Most of the respondents cannot afford electrical appliances although electricity may be available at home. The increase in household's income is too slow to permit households to switch from wood fuels consumption to efficient sources of energy for the purpose of baking and cooking.

The study revealed that urban and peri-urban households are not directly moving up the energy ladder even as their incomes grow. Electricity consumption is likely to reach nearly all the households in urban areas while a switch from kerosene to electricity will be seen for purpose of lighting. Almost all households have moved up the energy ladder and eventually switching to electricity for lighting not for cooking.

Fuel switching does not occur to the extent often hoped in the case of cooking. This implies that access to electricity might not be a very good indicator for the welfare of households. Electricity is the main source of energy only for lighting used by all the households in the study area.

Conversely, access and consistent availability of modern cooking fuels are important, for example, households that are willing and able to pay, simply will not make the switch from charcoal to LPG if the gas, stove, and gas bottles are not consistently available in a convenient location. This implies insignificant potential for reducing the pressure on local forest resources by substituting or switching from biomass to modern fuels.

4.2.2. Utilization of Cooking Devices and Kitchen Characteristics

The study has particularly stressed on those baking and cooking stoves which are widely in use by urban and peri-urban households. Households were asked if they possess and frequently use the major types of baking and cooking devices. Every household owns different types of stoves. As the survey data shows there are three types of stoves used for *Injera* baking. About 64.89 percent of households own traditional *Injera* baking stove(open earthen stove placed on three stones) and the *Mirt* stove, which burn fuel wood more efficiently, are used by 8.5 percent of households whereas, only a quarter of sample households (26.9%) were found to have adopted the electric baking stoves despite all sample households having access to electricity. The study also reveals that about76.75 percent of households use efficient *Lakech* stove. Inefficient traditional metal charcoal stoves are also still used by 9.57 percent of the sample households. Moreover, 9.27 percent and 25.08 percent of sample households own electric stoves and kerosene wick stoves, respectively. Simple biogas burners are also used by limited number of peri-urban households (2.58%). LPG gas stove is not included as it is not common in the selected sampled households. None of the sample households own a LPG stove.

It was found that all the sample households own more than one stove and only 11.72 percent of the sample households own all the stated kinds of traditional and modern stoves. A description of the different cooking appliances or stove holdings (used) by sample households is provided in Figure 4.1.

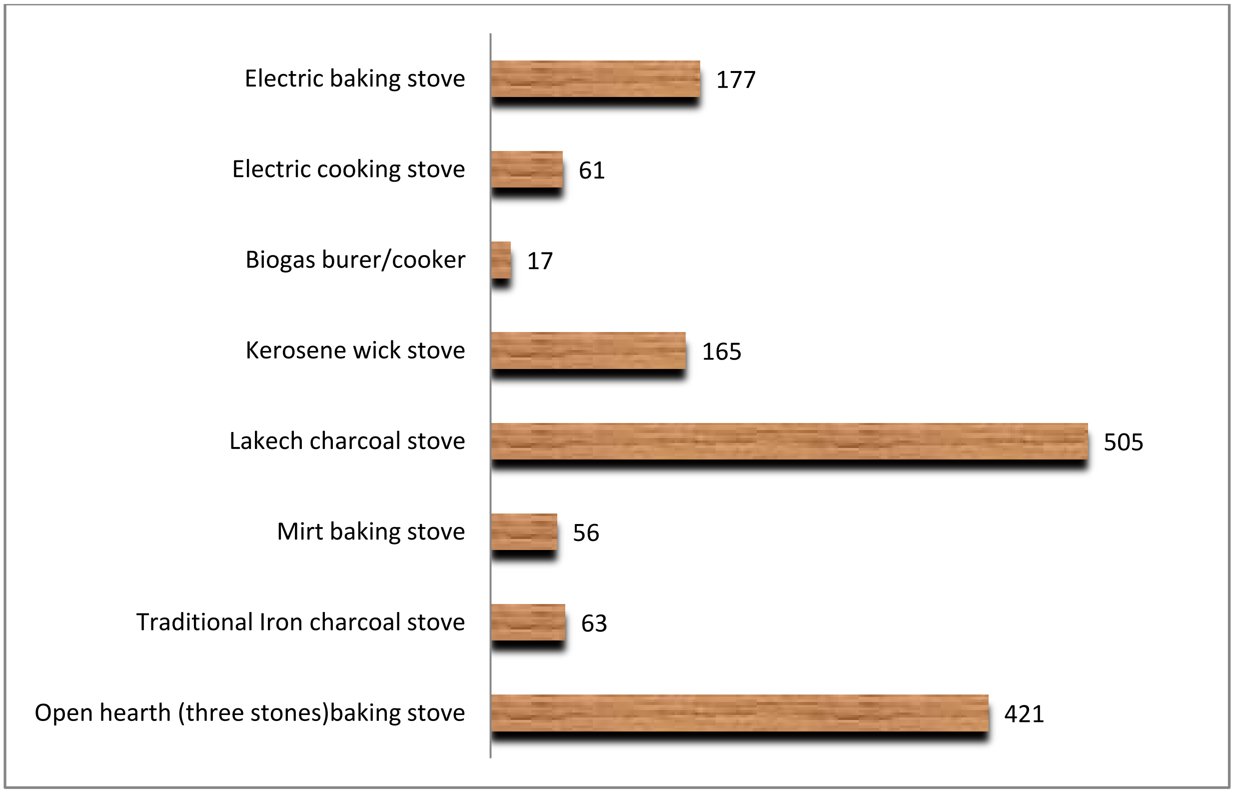


Figure 4.1.Number of Sample Households Owing Baking and Cooking Appliances

Source: Field survey, 2014

All sample households in the survey were asked their opinions about the access to appliances of higher quality. The costs of the available better appliances are beyond the purchasing ability of most of urban households. They cannot afford modern cooking appliances because they are too expensive for them. Therefore, most urban households cannot easily make a transition from biomass to electricity for cooking end-use since the high costs of modern cooking stoves are major constraints for them.

Ownership of stoves in urban areas can be a reflection of the ownership of independent kitchen environment. Kitchen problem has been identified as a major hindrance for smooth stove management. The majority of urban households use privately owned kitchens for *Injera* baking and cooking purposes. More than half of the households (51.98 %) have private kitchens that are separated from the main house for baking and cooking and about a quarter of sample households (25.68%) share kitchens with neighbors. The rest 22.34 percent of the households have private kitchens which were found attached with the living house. Most of the households who live in rented *kebele* houses share kitchen and this has become a problem to own fuel- saving technology for *Injera* baking which needs space for its installation. Kitchen problems as in the case of *Injera* baking was not mentioned in *Wot* and coffee preparation by the sample respondents as they can be performed indoor in a small space using mainly charcoal.

Cooking takes up a big portion of urban households' end-use energy consumption. Disparities in cooking practices were not reflected across the different socio-economic groups. The conditions of cooking in most households are poor; kitchen location affects the exposure to and concentration of pollutants. Most of the kitchens were built in simple ways having no proper ventilation. Only 12.2 percent of urban household respondents have a chimney and 60.4 percent of the urban household respondents do not have a window in the indoor areas where cooking of food takes place.

The primary cause of this indoor air pollution is household fuel use, particularly from traditional fuels burned in highly inefficient stoves. The biomass fuels, used in poorly ventilated kitchens, produce large quantities of smoke that could turn the kitchen wall into thick dark. A lack of space around the kitchen and poor ventilation or chimney systems for the smoke leads to very high level of exposure to the pollution in the homes, especially of women and young children.

It is important to improve the efficiency of the traditional cooking stoves and change their cooking practices by employing cleaner alternatives fuels and end-use technologies to improve energy efficiency so that the pressure on surrounding forests could be alleviated and household energy-related problems tackled. In addition to adopting improved stoves, women need to have well housing status. There is a need to scale up the kitchen and housing conditions for cooking since many of the households were found to be not only lacking their own houses but also living in overcrowded rooms with poor housing conditions and lacking basic facilities.

4.2.3. Domestic Use of Lighting and Other Electrical Appliances

As already said when urban households get connected to electricity they generally continue to use biomass fuels for cooking and the use of electricity was mainly for lighting and TV viewing and radio listening rather than cooking. Yet only 4.21 percent of the sample households rely on electricity to cook. Most of the households in the urban and peri-urban areas today rely on electrical energy to meet their lighting. Consequently this helps to make home life more convenient and housework easier and reduce the time spent by women on cooking and preparing food and provide opportunities for extended working hours and thus improve income generation. Although electricity is considered to be the best energy option as it can be used for multiple applications, it does not help address the major energy problem that most households in area face in terms of their daily cooking requirements.

Assessment of fuel end-use for electricity showed that, almost all households (97.42%) claimed to use electricity for lighting while a minority (2.58%) in the peri-urban area reported the use of biogas as their main source of light. Most of the households surveyed had no mention of using kerosene as main source of light. In addition to electricity, a majority of households use candles (72.30%) and rechargeable lamps (33.45%) during periods of power outages. The widespread use of candles can be attributed to their accessibility. Despite the use of battery-operated torches has decreased markedly, an insignificant number of households continue to use battery-operated torches (4. 25%).

The change seems to be a result of households switching to rechargeable torches (15.05%). Of the appliances used to produce light, the type of light bulbs most household frequently installed are incandescent light bulbs (78.32%) andenergy saving fluorescent light bulbs (19.10%), while a minority of sample households (2.58%) living in peri-urban area utilized biogas lamps. The detail information on the number of light bulbs used among households is shown in annex 5.

As shown in Table 4.13, three fourth of the sample households (75.23%) used two sources of energy (electricity and candle), 15.05 percent used electricity and dry cell batteries, 7.14 percent used electricity and kerosene; and 2.58 percent used electricity and biogas as the energy combinations used in lighting their homes. Electricity and biogas were the most predominant fuels among the peri-urban households. The popularity of these fuels was due to their multiple uses. These fuels could be used for lighting as well as for cooking.

Table 4.13. Percentage Distribution of Survey Households by Type of Mixture of Fuels in the Domestic Function of Lighting

Households Involved	**Candle and Electricity**	**Kerosene and Electricity**	**Biogas and Electricity**	**Dry cell Battery and Electricity**	Total
Frequency	495	47	17	99	658
Percentage	75.23	7.14	2.58	15.05	100

Source: Field survey, 2014

As can be seen from Table 4.14, the average monthly household and per capita end-use energy consumption for lighting in terms of heat value are 494.16MJ and 116.64 MJ, respectively. In terms of end-use energy consumed for lighting, electricity occupies the leading position (98.84%). Among all lighting energy sources, in terms of per capita consumption, the proportion of electricity is also highest (115.40MJ) which is 98.94percent. It was found that average household consumption of electricity for lighting was 181.03kWh while it was only 54.80kWh for baking and cooking purposes. This suggests that electricity consuming household utilize about 6.03kWh and 1.83kWh of electricity per day for lighting and cooking, respectively. The average monthly candle and dry cell battery consumed by a household was about 3.17 and 0.41 pieces.

Table 4.14:Mean Monthly Lighting End-use Energy Consumption (in MJ) Based on Appliance Efficiency Level

Fuel Type	Appliance used	Appliance Efficiency level (%)	Household End-use energy (MJ)	Per capita End-use energy (MJ)
Electricity	Electric Bulb	75	488.42	115.40
Candle	Candle	65	3.87	0.93
Dry cell	Dry cell Battery	75	0.003	0.0007
Biogas	Biogas Lamp	55	1.87	0.31
Total			**494.16**	**116.64**

Source: Field survey, 2014

Electricity is regarded as a cleaner energy option for lighting purpose, and it is also used for additional household appliances such as refrigerators, televisions, tape recorders, radios, ironing and ventilators. The proportion of households using various types of energy for other function is shown in Table 4.15. As the table indicates the proportion of households using electricity for domestic lighting was 97.42 percent while biogas lighting is only 2.58 percent. Over 90 percent of the sampled households possesses TV sets and more than half (52.58%) claimed they have refrigerators in their houses. Nearly three fourth of the sample households (74.47%) are using electricity for their radios. The proportion of sample households using electricity for the purpose of ironing is 6.39 percent while it was nil for ventilation and air conditioners. The proportion of sample households having only one type of electric using equipment was 13.9 percent while 34.5 percent have four and above electric using appliances.

Table 4.15: Percentage Distribution of Survey Households by Lighting and other Electrical Appliances

Non Cooking Appliances		**Households Involved**	**Percentage of Responses (%)**	**Percentage out of 658**
Lighting devices	Electric Lamps	641	24.62	97.42
	Biogas Lamps	17	0.65	2.58
Ironing devices	Electric Irons	42	1.62	6.39
Cooling devices	Refrigeration	346	13.29	52.58
Information & entertaining devices	Television sets	606	23.27	92.10
	Tape Recorders	462	17.74	70.21
	Radio sets	590	18.82	74.47
Total		**2,604**	**100**	

Source: Field survey, 2014

CHAPTER FIVE

5. GENDER DISPARITY ON THE END-USE ENERGY UTILIZATION PATTERNS

This chapter examines the relation between energy and gender at the household level with a view to explain gender disparity on fuel utilization Demographic and socio-economic characteristics of the sample households are discussed in the first section and patterns of energy consumption among households in the second.

5.1. Demographic and Socio-economic Characteristics of MHHs and FHHs

5.1.1. Sex, Age, Household Size and Composition

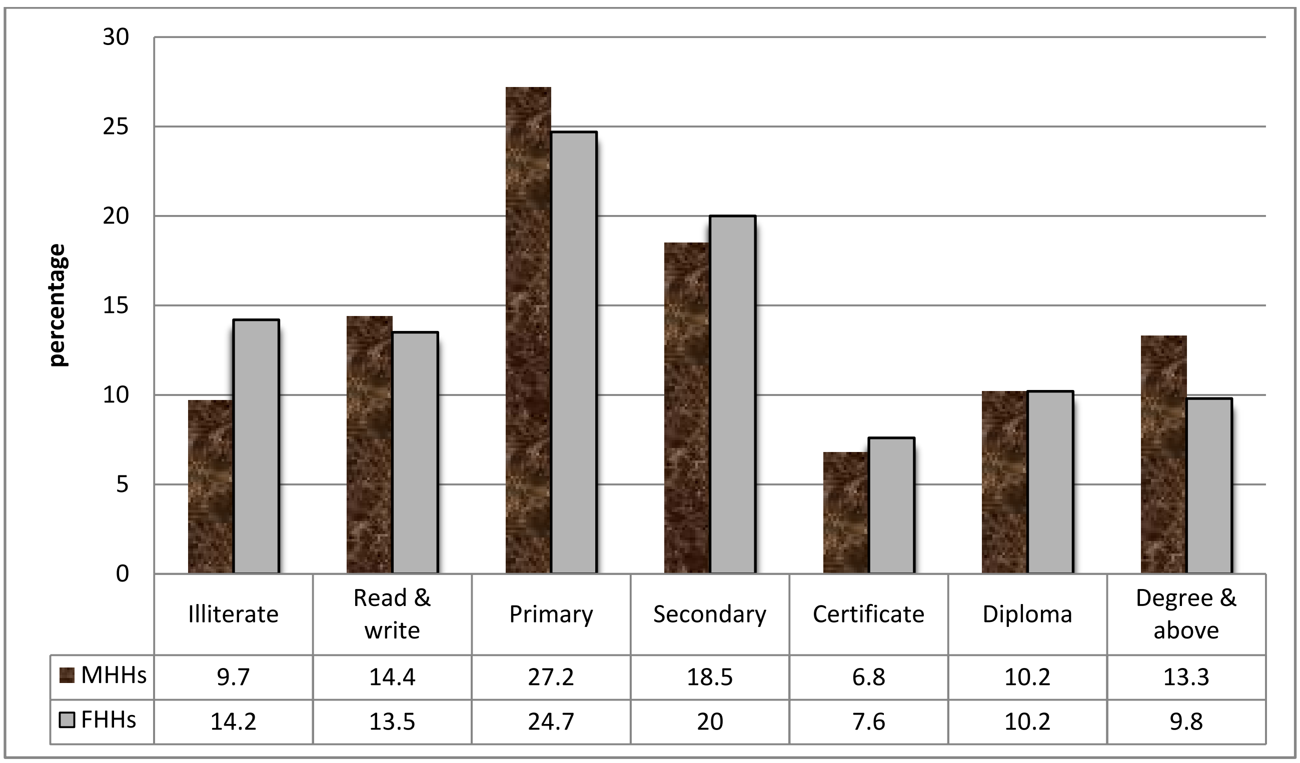
The gender composition of households reveals that MHHs are more in number (383) than their female counterparts (275).One of the most important characteristics of households that need to be considered is the size of the household and its composition. The family size in these households, range from 1 to 10 while the average is around 4.3.The median household size was higher in the peri-urban area than in the town. The total number of family members in the sampled households was 3,180, of which female constitutes 51.95 percent and male 48.02 percent. The majority of the sample respondents (65.96%) have reported to have between 4 and 6 family members while a few of them (21.28%) have between 1 and 3 members. On average, there are 4.83 family members in a household while the range is between 1 and 10. There is difference on average family size between the two groups of households where MHHs and FHHs have 5.40 and 4.08 members, respectively.

Out of the selected 658 sample households, the maximum age observed from sample respondents was 68 while the minimum is 23. The majority of the respondents (41.64%) are found between 41 and 50 age range. About 39.82 percent of the respondents are in between 31 and 40 age group. About 9.88 percent of the respondents are less than 30 years old while 6.69 percent of them lie in the range of 51 - 60 years. The remaining 1.99

percent aged over 60. The minimum and maximum age in MHHs is 23 and 68 years respectively while the corresponding figures for FHHs is 27 and 60 years. The majority of MHHs age between 41 and 50 years while the FHHs in the age range of 31 – 40 years.

5.1.2. Educational and Marital Status

Almost three fourth of the sample households (74.4 %) have attended formal education and are literate. Respondents having diploma and above constitute 22.1 percent of the total sample population while 19.15 percent and 26.1percent had attended secondary and primary level education, respectively. Only 14.0 percent of them have never attended formal education but can read and write. The detail information on educational level of household heads by gender is shown in Figure 5.1.



	Illiterate	Read & write	Primary	Secondary	Certificate	Diploma	Degree & above
MHHs	9.7	14.4	27.2	18.5	6.8	10.2	13.3
FHHs	14.2	13.5	24.7	20	7.6	10.2	9.8

Figure 5.1. Percentage Distribution of Sample Households' Education Level by Gender

Source: Field Survey, 2014

The incidence of households headed by female is very likely to grow in the study area due to various causes. The termination of marriage either through divorce or widowhood or separation, is the major factor that brings women in the forefront of heading the households. Widowhood was the most common reason for being the breadwinner of the household for the majority of women (72.7%).The proportion of divorced female heads take the second position (7.3 %) followed by separated women heads with the percentage share of 4 percent. In the case of MHHs, the majority (87.23%) of them were married while single heads took the least proportion, only 3.1 percent (Figure 5.2.).

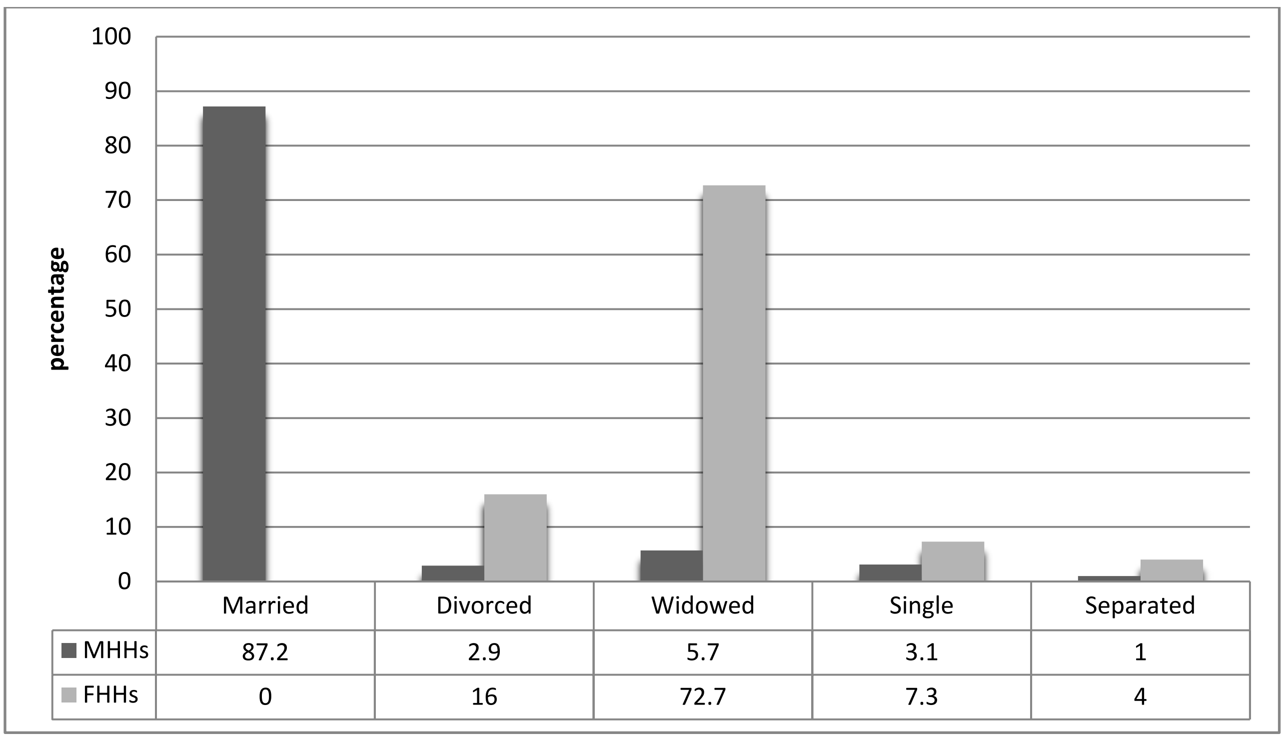


Figure 5.2. Percentage Distribution of Sample Households' Marital Status by Gender

Source: Field Survey, 2014

5.1.3. Housing Conditions and Tenure

Regarding housing conditions, the majority of the residential units are poorly constructed and of low standard. This is an indicator to the low living conditions of the sample households. The majority of the housing units (89%) is made of mud, wood and corrugated sheets while only a small share (11%) of the residential units built using hollow blocks or concretes. The major materials used for the construction of wall in the study area are wood and mud (79.2%), stone and cement (16.4%) and hollow blocks (4.4%). It was also observed that most residential units are of standalone types (83.1%) while 16.9 percent of the dwelling units are attached row houses.

With respect to dwelling ownership of the sample households, currently more than three fourth of the sample households (75.4%) live in their own houses, and 17.5 percent and 7.1 percent in rented *kebele* and private houses, respectively. About 31 percent of the FHHs had no houses of their own and more than a quarter (28%) of them live in overcrowded single rooms Whereas nearly 80 percent of MHHs live in own houses and the rest 20 percent live in rented houses. The average monthly rent ranges from 125.00 ETB for a house rented from *kebele* to 2,500.00ETB for a house rented from private owner.

In spite of differences in ownership status, the socio-economic background of the participants indicates that most of those living in *kebele* administering houses have relatively lower level of income compared to those living in the private houses. Those who lacking own houses are also living in an overcrowded rooms and poor housing conditions with a serious lack of basic facilities. Furthermore, the survey result shows households renting houses from individuals perceive their payment is too much as they are paying according to the interest of the meter owner.

5.1.4. Income and Occupational Status

The mean per capita annual income was lower for FHHs (3,758.97 ETB) compared to MHHs (7,538.54 ETB) for MHHs (Figure 5.3). The proportion of those who earn more than annual per capita income of 8,000.00 ETB are higher in MHHs (26.37%) compared to FHHs (18.91%). The detail information on mean annual per capita income (ETB) by gender and occupation is shown in annex 6.The majority of the FHHs (81.09%) have reported that their annual per capita earnings are below 8,000.00 ETB while only 4.0 percent of the households had a monthly income of 12,000.00 ETB and above. The highest monthly income for MHHs may go as high as 6,500.00 and the lowest as low as

900.00 ETB with an average monthly income of 2,490.30 ETB. While in the FHHs, the highest and the lowest monthly income are 6,000.00 ETB and 800.00 ETB respectively with an average monthly income of 2,071.00 ETB.

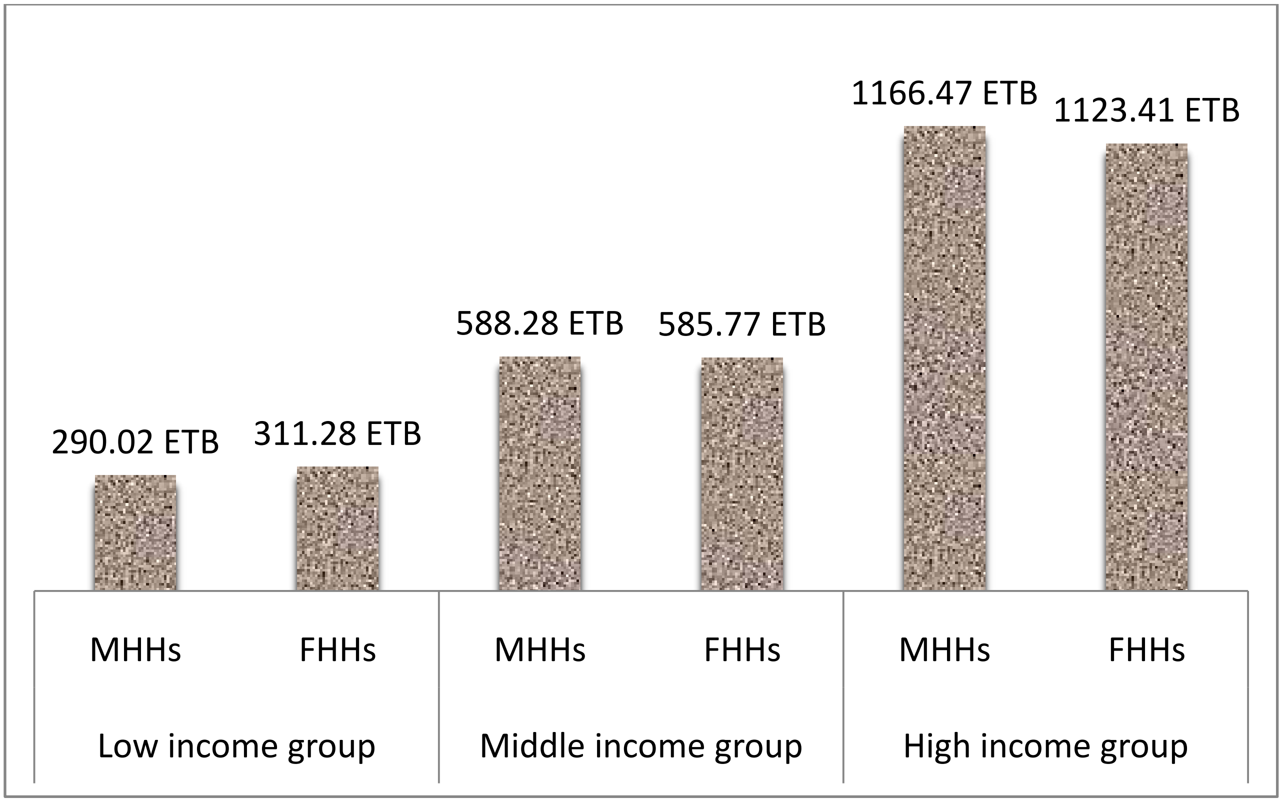


Figure 5.3. Mean Monthly Per capita Income (ETB) by Income Group and Gender

Source: Field Survey, 2014

When the two groups are compared based on the occupation of respondents, MHHs are more engaged in the informal sector than FHHs. The majority of FHHs (36.7%) engaged on petty trades while a large percentage of the MHHs are employees (Figure 5.4.)

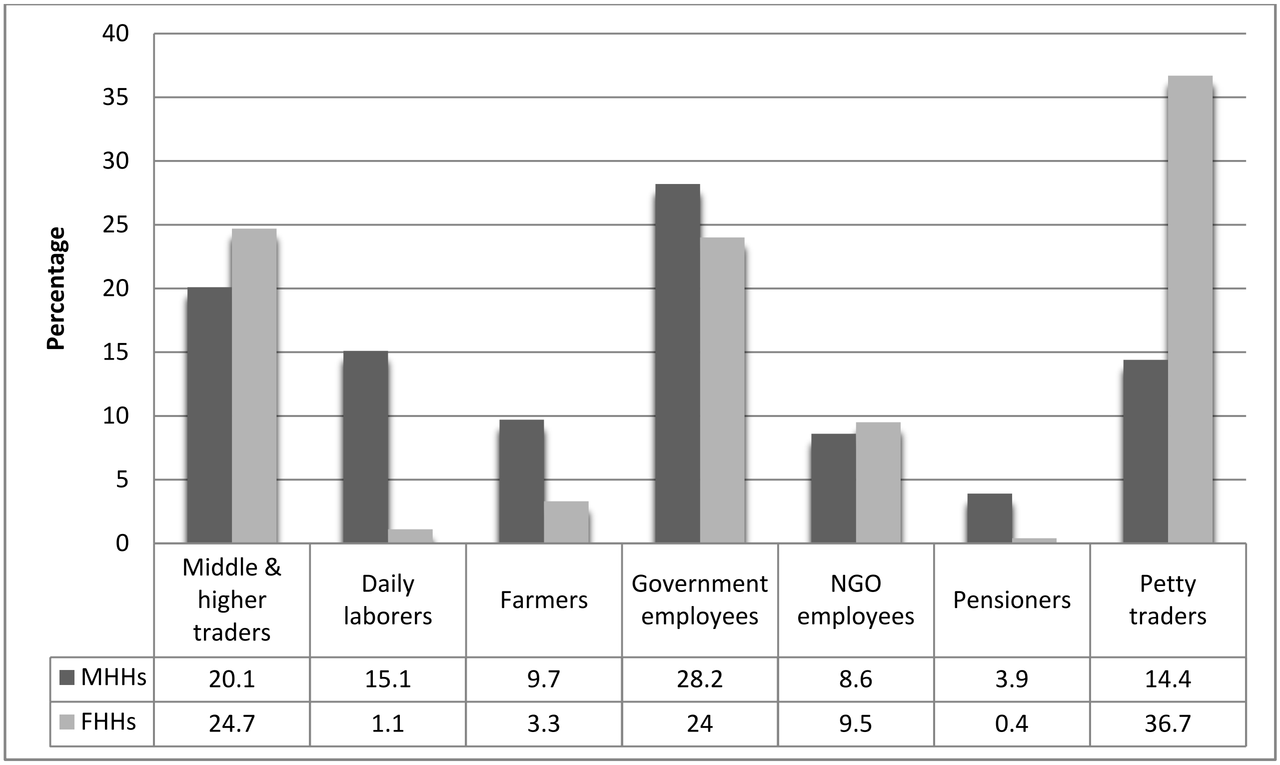


Figure 5.4. Percentage Share of Main Income Source of Sample Households

Source: Field Survey, 2014

5.2. Gender Disparity in Energy Expenditures and Consumption

The minimum and maximum expenditures were 28.66 ETB and 455.81 ETB for MHHs while they are 37.66 ETB and 447.78 ETB for FHHs, respectively. The mean monthly per capita expenditure ranges from 63.78 ETB for the MHHs to as high as 74.23 ETB for the FHHs. The average monthly expenditure made on energy per household was 284.77 ETB for the MHHs and ETB 297.65 for the FHHs. That means MHHs and FHHs are spending 11.44 percent and 14.37 percent of their average incomes, respectively. This shows that FHHs use a higher average income than MHHs for purchasing energy (Table 5.1).

Table 5.1. Mean Monthly Income and Fuel Expenditures for Households Headed by Males and Females (ETB)

Gender	Household Income (ETB)			Fuel Expense (ETB)			As % of Income
	Mean	SD	Cv	Mean	SD	Cv	
MHHs	2,490.30	1,148.38	46.11	284.77	76.28	26.79	11.44
FHHs	2,071.00	913.92	44.13	297.65	64.5	21.67	14.37

Sd: standard deviation Cv: coefficient of variation

Source: Field Survey, 2014

Table 5.2.Mean Monthly Expenditures (ETB) by Gender and Fuel Type

Gender	Mean per household Expenditure (ETB)						
	Fuel wood	Charcoal	Sawdust	Kerosene	Electricity	Candle	Dry cell
MHHs	78.00	90.55	1.92	10.71	92.50	9.36	1.72
FHHs	86.81	91.90	0.93	14.4	91.19	9.92	2.51
Mean per capita Expenditure (ETB)							
MHHs	16.35	20.28	0.39	2.64	21.60	2.14	0.38
FHHs	22.17	22.78	0.23	3.42	22.46	2.53	0.64

Source: Field Survey, 2014

Mean monthly household and per capita gross energy consumption is 2,230.62MJ and 500.49MJ for the MHHs, and 2281.70MJ and 567.12MJ for FHHs, respectively. The average monthly gross domestic biomass fuel consumed by MHHs was1, 339.15MJ and it was 1398.94MJ for FHHs while the average monthly per capita biomass energy consumption is 292.60MJ for MHHs. The figure rises to 350.05MJ for FHHs. With respect to the average monthly gross household and per capita conventional fuels consumption was 891.47MJ and 207.89MJ for MHHs whereas FHHs consumed 882.76MJand 217.07 MJ, respectively (Table 5.3.).

Table 5.3. Mean Monthly Gross Energy Consumption (MJ) by Gender and Fuel Type

Gender	**Mean per household Consumption(MJ)**							
	Fuel wood	Charcoal	Sawdust	Dung cake	Kerosene	electricity	Biogas	Candle
MHHs	446.93	861.14	6.43	24.65	25.17	855.49	5	5.81
FHHs	497.41	873.95	3.11	24.47	33.84	840.77	1.99	6.15
Mean per capita Consumption(MJ)								
MHHs	93.67	192.89	1.29	4.75	6.21	199.57	0.78	1.33
FHHs	127.06	216.63	0.76	5.6	8.03	207.09	0.38	1.57

Source: Field Survey, 2014

As it has been seen on Table 5.3, electricity and charcoal show the highest figure compared to other fuels with regard to the average monthly gross energy consumption for both MHHs and FHHs. Mean monthly household gross consumption of electricity was 855.49MJ and 840.77MJ for MHHs and FHHs, respectively. Conversely, both the mean monthly per capita gross consumption of electricity and charcoal was higher for FHHs compared to MHHs.

Table 5.4.Mean Monthly End-use Energy Consumption (MJ) by Gender and Fuel Type

Gender	Mean per household Consumption (MJ)							
	Fuel wood	Charcoal	Sawdust	Dung cake	Kerosene	electricity	Biogas	Candle
MHHs	44.70	172.23	1.03	2.96	12.59	641.62	2.50	3.77
FHHs	49.74	174.79	0.5	2.94	16.92	630.58	0.99	4.0
Mean per capita Consumption (MJ)								
MHHs	12.71	43.33	0.12	0.67	4.01	155.32	0. 19	1.02
FHHs	9.37	38.58	0.21	0.58	3.10	149.68	0.39	0.86

Source: Field Survey, 2014

Similarly, electricity and charcoal show highest figure compared to other fuels with regard to the average monthly end-use energy consumption for both MHHs and FHHs. Both mean monthly household and per capita end-use consumption of electricity were higher for MHHs compared to FHHs. Mean monthly per capita consumption of fuel wood and charcoal was higher for the MHHs. Conversely, the mean monthly household end-use fuel wood and charcoal consumption was higher for FHHs compared to MHHs (Table 5.4.).

From the data in Figure 5.5, it is apparent that both the average household and per capita gross energy consumption is higher for the FHHs than MHHs whereas the reverse is true in the case of average end-use energy consumption. The average monthly household and per capita end-use energy received by MHHs were 881.40MJ and 217.18MJ while FHHs consumed 880.46MJ and 202.77MJ, respectively. The respective mean monthly household and per capita end-use conventional energy consumption are lower (652.49MJ and 160.35MJ) for FHHs while they are higher (660.48MJ and 154.03MJ) for the MHHs. However, the average monthly household and per capita end-use biomass energy consumption are higher (227.97MJ and 56.58MJ) for the FHHs while they are lower (220.92MJ and 48.74MJ) for MHHs.

This implies that those FHHs were more likely to use efficient biomass fuel stoves than MHHs. FHHs prefer energy services to ease the burden of reproductive work that is essential in sustaining their families´ health and sense of self-esteem. They rate cooking as the most important energy service needed. Safety is a major concern of women when cooking. Women are interested by the smokelessness and convenience of fuel for cooking while men tend to decide in favor of lighting and watching television and listening to music. There can be gender differences in perceptions of the benefits of biogas. The women mainly spoke of time saved in fuel wood collection and cooking, the men appreciated faster cooking. Convenience, health and safety are major concerns of women in their use of fuel and the stove. They need more modern, sustainable energy sources which can improve their work and their quality of life.

In FHHs the introduction of more efficient stoves can make a significant saving to household energy costs and thereby contribute to poverty alleviation. The evidence presented in this section suggests that gender issues are therefore to be integrated in other development programmes and women should be the focus of efforts to bring access to modern energy, since bringing energy to women helps lift communities out of poverty. The detail information on the share of average gross and end-use energy consumption by gender is shown in annex 7.

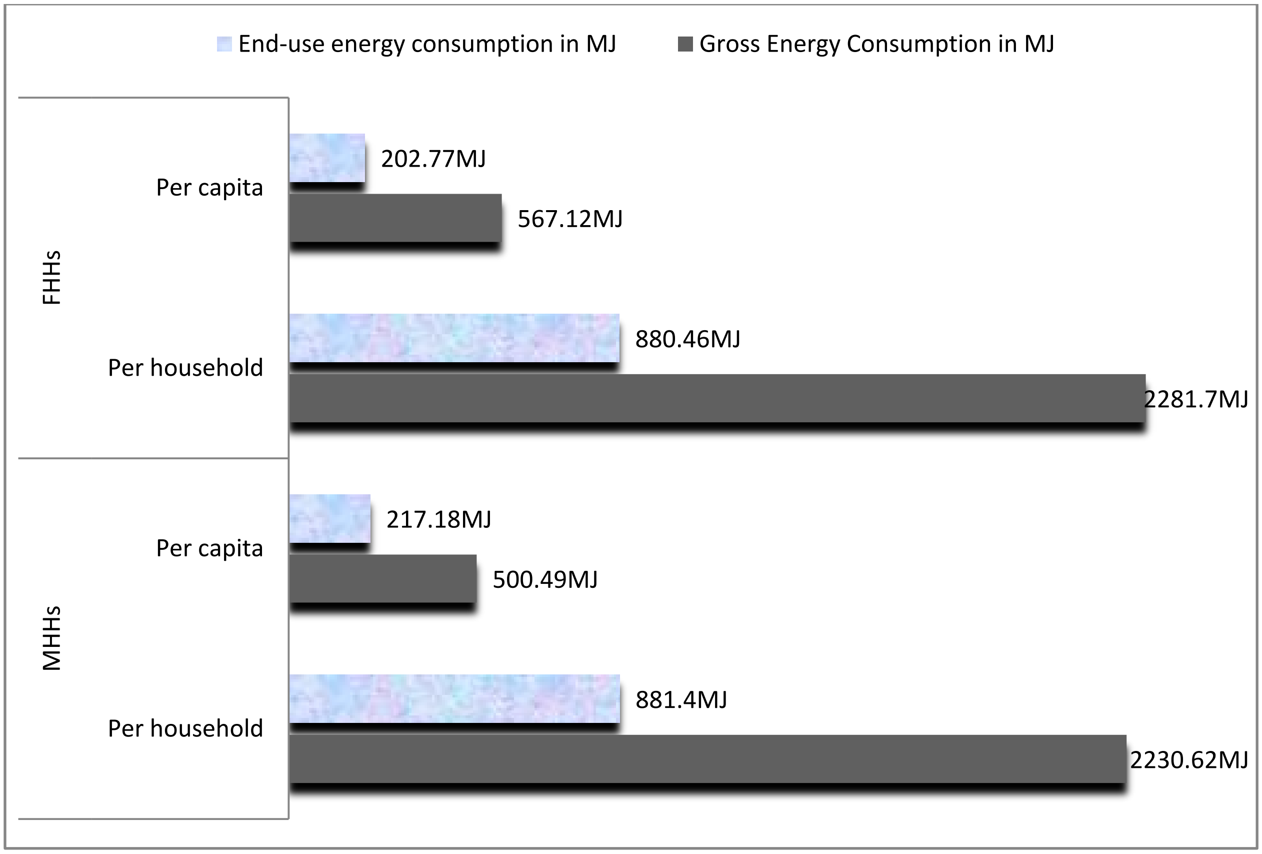


Figure 5.5. Mean Monthly Gross and End-use Energy Consumption (MJ) by Gender

Source: Field Survey, 2014

5.3. Gender Role and Household Energy Management

To understand gender roles of energy management, it is essential to know the individual's involvement in baking and cooking foods. The study focused on the views of women as they had primary responsibility for cooking within the household. It may have been useful to include male heads as they are often in charge of the household's finances, and therefore likely to be influential in household decisions to fund new cooking methods. The results have shown that women have the highest exposure to indoor air pollution and suffer from negative health effects since they spend considerable time around cooking fires in a kitchen. As can be seen from the Figure 5.6., women have all the responsibility of baking and cooking activities at home. It shows baking *Injera* and cooking foods are traditionally a women's job in the area. Females take the lion's share of baking and cooking responsibility. Most actively involved groups in cooking were usually females aged over 15 years of age. Daughters, female heads and housewives respectively are usually responsible in preparing and cooking foods and drinks.

Housewives involved in cooking frequently for making *wot* (29.23%), baking I*njera* (26.33%) and for cooking local foods (9.90%). Female heads are regularly make cooking to prepare *Wot* (28.15%), baking *Injera* (25.31%). Moreover, daughters are also chief cooks to prepare *Wot* (19.78%), *Injera* (10.73%) and local foods (10.45%). While, housewives, female heads and daughters are the chief cooks, at the same time, they are also always taken the effort of giving a hand in the main baking and cooking activities. Nearly all of males in urban households are not at all involved in baking and cooking. Among peri-urban households, despite the fact that boy children sometimes take the effort of giving a hand in cooking local foods, women take on the responsibility of cooking. Families believe that male involvement on cooking is not cultural; males spend most of the time outside home to fulfill the households' demands.

Women are largely responsible for meal preparation in the household using traditional fuels. Cooking is not only women's most time- and effort-consuming energy need; it is also a very large share of household energy consumption. Since cooking is often conducted in indoor kitchen areas the biomass combustion exposes women to high quantities of indoor air pollution which results in poor health conditions for women. Thus, the responsibility for household energy provision affects women's health disproportionately to men's. There are possibilities for improving the position of women through energy. When communities gain access to energy services, it can have a marked effect on their lives, particularly with respect to freeing up their time, improving their health and well-being, and opening up opportunities such as enabling them to improve their earnings to improve their living situations.

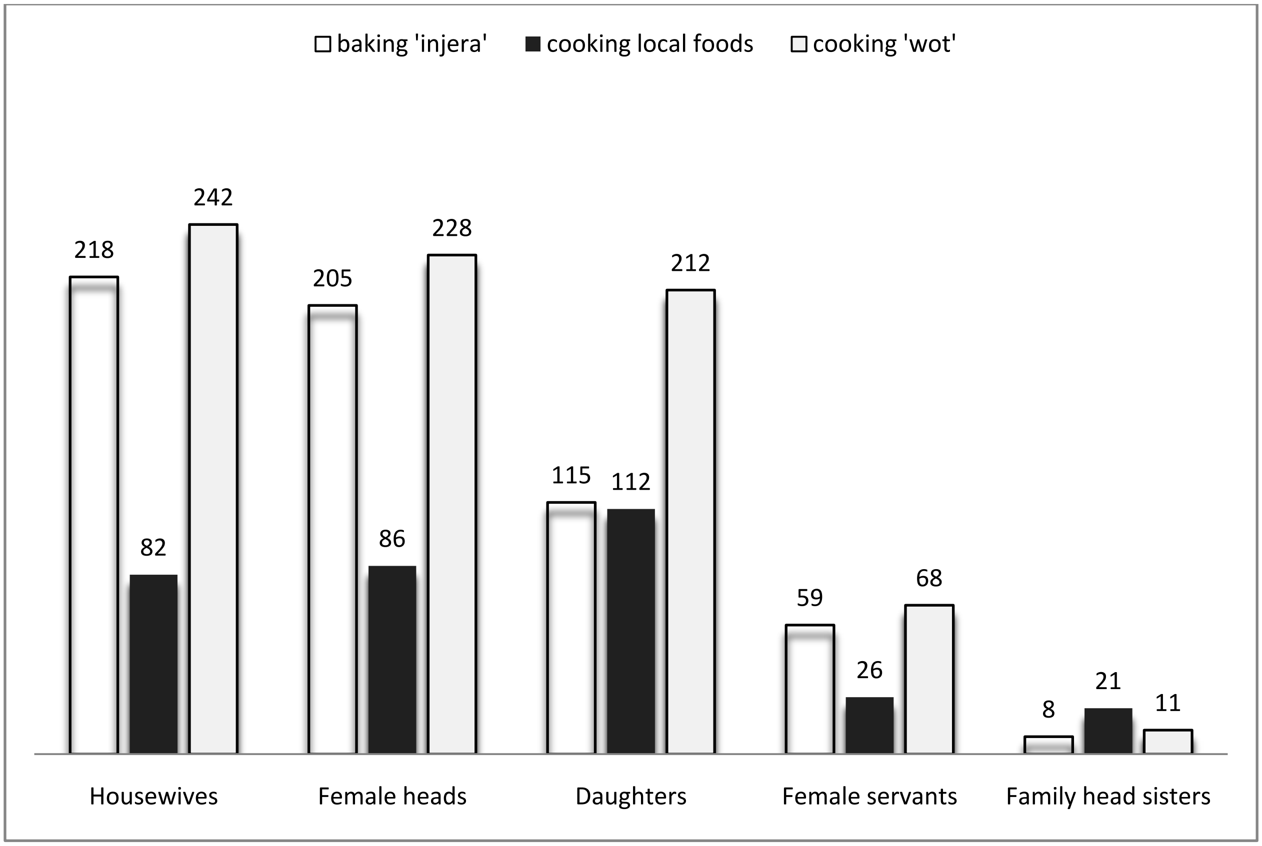


Figure 5.6.Number of Female Involvement in Baking and Cooking Activities

Source: Field Survey, 2014

The amount of fuel consumption with traditional cooking systems and the time consumed has been an issue for all concerned. As women were always occupied with household chores including the management of household energy resources, they have very little time for other economic and social activities that could enable them to be empowered socially and economically.

It is a widely held view that managing biomass energy for cooking has a significant impact on women's workload and their health, which have hindered their capabilities and opportunities for participating in economic and other social activities. Therefore, to minimize the workload of women, the dissemination of efficient, modern and appropriate improved stoves is inevitable.

CHAPTER SIX

6. HOUSEHOLDS' ENERGY USE AND INCOME POVERTY

This chapter discusses households' energy use patterns in relation to their socio - economic status. Using the income poverty perspective the chapter explores the pressures on household budgets caused by a given fuel requirement, and the existing energy poverty situation among households. Energy expenditure is used as a measure of energy poverty and as the main determinant of household energy poverty status.

6.1. Income Generating Activities

In the survey questionnaire, respondents were asked how much each member of the household contributes to the household on a monthly or yearly basis. It is apparent from Figure 6.1. that the main occupation pattern of the households (35.5%) imparted that they are full time private and government employees and they receive much of their income from monthly salaries. Almost two-thirds of the participants (64.59 %) of households do not earn a regular income or salary. They are totally dependent on other sources of income-generating activities. Nearly a quarter of sample households (23.6%) rely on petty trade for their main source of income. Medium and higher traders occupy the next position (22.1%) followed by daily laborers (9.3%), private employees (9.1%), farmers (7.1%), and the rest (2.5%) was pensioners.

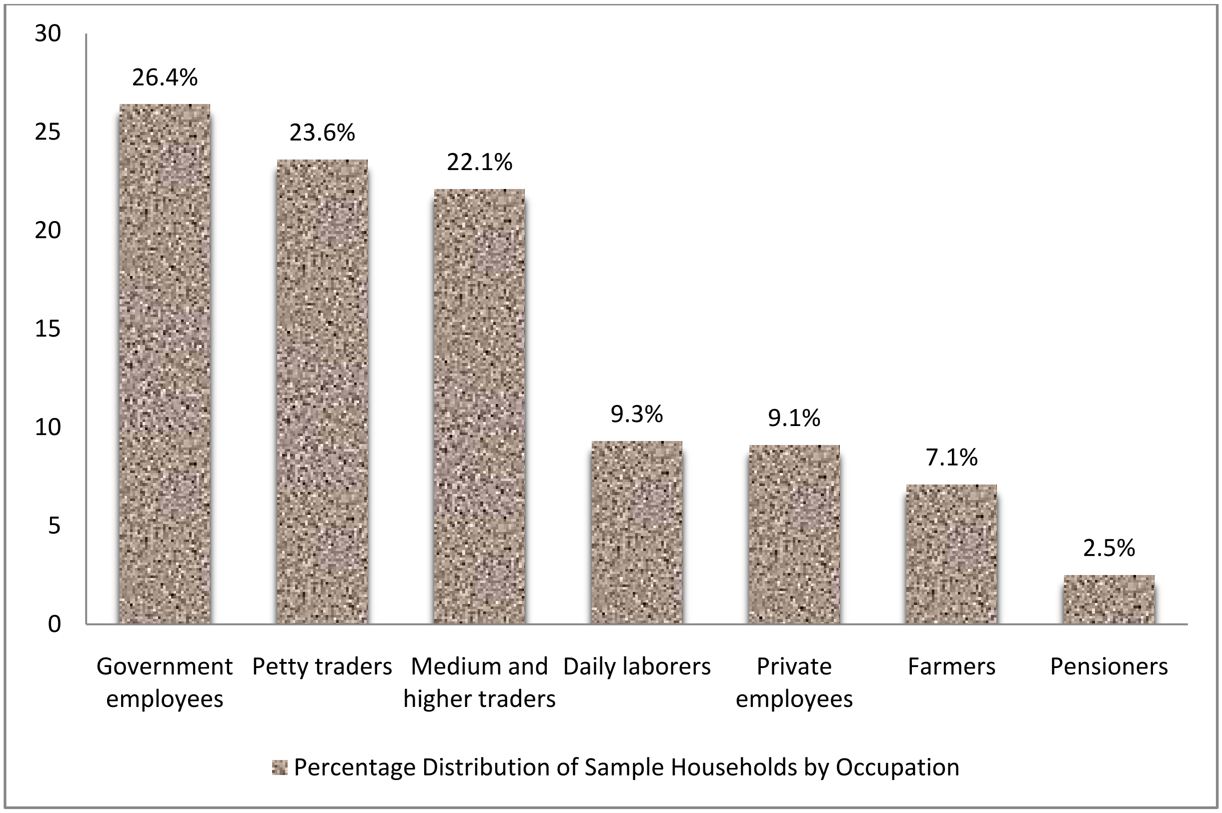


Figure 6.1 : Percentage Distribution of Survey Households by Occupation

Source: Field survey, 2014

The annual income of households was quantified by taking into consideration incomes from all possible sources. For those who engaged in farming, livestock income was quantified from sales of livestock and livestock products and crop income was quantified from the sale of all crops, including cereals, pulses, horticultural crops and other cash crops during the year. The better off households in peri-urban area continue to engage in irrigated fruit farming and normally earned their main income through the sale of fruits, particularly banana and mango. Besides fruits, some households sell a small part of their own harvest, like maize. Though a quarter of all households do not own any livestock, not even chickens, few households earned their income from the sale of livestock and livestock products, including cattle, goats and chicken.

Although much of the discussion on income sources tends to assume that households rely predominantly on one source of income, the study considers different other (additional) income-generating sources that bring money into the households, these tended to include salaries of spouse or any other household member, earnings from crop and livestock sales, petty trades, house renting and the receipt of gifts from remittances.

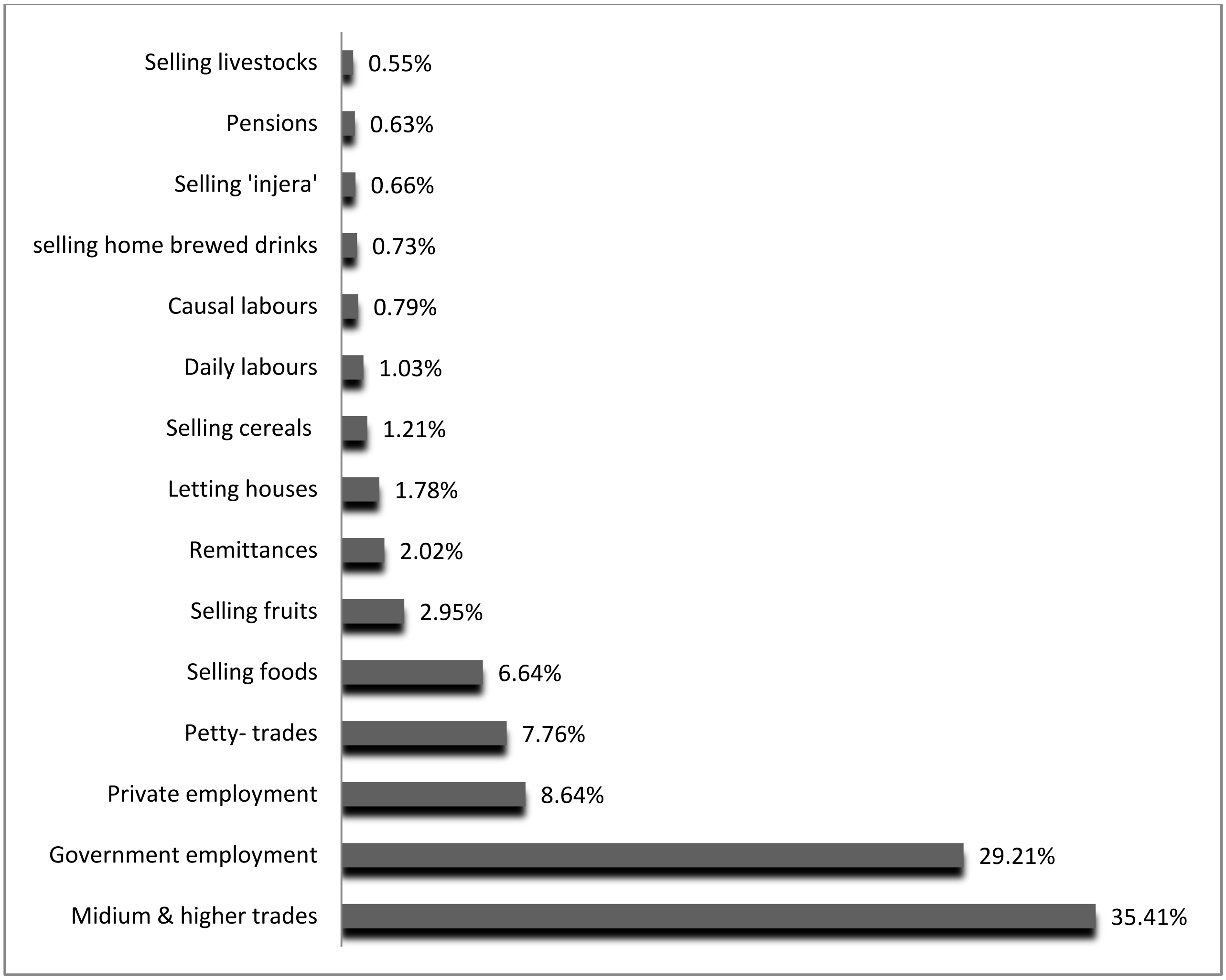


Figure 6.2. Percentage Distribution of Monthly Income by Source of Income

Source: Field survey, 2014

The share of main income sources for the household is 79.67 percent while income generated from additional sources constituted 20.33 percent. The two most significant sources of additional income for the sample households are salaries (37.85%) and running medium and higher businesses (35.41%). Furthermore, petty- trading (7.76%), preparing and selling foods (6.64%) and sale of fruits (2.95%) are also most important additional income generating activities contributing considerable amount to the households (Figure 6.2).

Remittance, casual labor and house renting are also mentioned as sources of income in urban and peri-urban households. In many instances these remittances are in the form of money given mostly by children to their parents. Nineteen percent of peri-urban households obtained the bulk of their cash income from casual labor employment which is mainly of local agricultural work. They are hired for the harvesting of bananas and cotton as well as for land preparation, planting and weeding. The opportunities for casual employment include local agricultural work. Local labor is hired throughout the year for the harvesting of bananas and cotton as well as for land preparation, planting and weeding.

Table 6.1. Percentage Distribution of Survey Households by Mean Annual Per capita and Mean Monthly Per household (in ETB and %)

Annual per capita Income (ETB)	Households Involved	%	Mean Monthly Income (ETB)	Households Involved	%
Below 4,0001	215	32.67	Below1,001	216	32.83
4,001-8,000	290	44.07	1,001 -2,000	203	30.85
8,001-12,000	110	16.72	2,001-3,000	166	25.23
12,001-16,000	31	4.71	3,001-5,000	69	10.49
Over 16,000	12	1.82	Over 5,000	4	0.61

Source: Field survey, 2014

As shown in Table 6.1., nearly a quarter of the households (23.25%) are earning annual per capita income of more than 8,001.00 ETB a year whereas 76.74 percent of the residents earn annual per capita income of less than 8,000.00ETB to support basic needs of their family members. Similarly, the study revealed that almost two-thirds of the sample households (63.68%) earn mean monthly income of less than 2,000.00 ETB. Out of the survey households only 11.10 percent of the households were having an income greater than 3,000.00 ETB per month.

Sample households have been asked their perceptions about their incomes over the last 12 months. The majority (35.1%) have the opinion that their incomes have shown slight increase. Nearly a quarter of sample households (23.3%) felt their household incomes slightly decreased. 29.0 percent have stated that their incomes have shown no change; it was neither increasing nor decreasing. The rest 7.2 percent and 5.1 percent of sample households said their incomes show significant decrease and increase, respectively. Residents in peri-urban area were much more inclined to state that their incomes significantly increase compared to residents in the town. Those residents who perceive improvement in their income level of households are clearly seen in peri-urban area due to large sell of fruits from their farms, compared to residents in the town.

6.2. Household Income and Fuel Expenditure by Income Category

The annual income of households was quantified by taking into consideration incomes from all possible sources. Then it was converted into annual per capita income by taking the total gross household income divided by the total number of family members living together.

All households selected on the basis of their residential housing units and gender may not necessarily indicate the wealth of the households. Therefore, to identify the income poor and well off residents in the study area, household income survey was conducted. Households were asked to estimate their income in a previous month or year and they are grouped under different income categories on the basis of their annual per capita income which was calculated for each household by taking the total gross household annual income divided by the total number of family members living together. According to the criterion used by the MoFED calculates the income based poverty line every year after adjusting inflation. For year 2010/11, income of Birr 850.00 for urban households is identified as the poverty line. A recent estimate finds that about 30.6 percent of the population was estimated to live under the poverty line (MoFED 2011).

Based on household annual per capita income, the sample households were grouped into three income groups. Sample households were grouped under high, middle, and low-income groups. Out of the total survey households, nearly half of the sample households (47.42%) have annual per capita income of below 5,000.00 ETB and belong to the low income category. About 39.36 percent were earning in between 5,001.00 and 10,000.00 ETB and belong to the middle income households, and nearly a quarter (13.22%) were having an income greater than 10,001.00 ETB per year and belong to high income category. Such income categorization cannot be generalized and hence is not a representation of the situation in the entire country. It may differ from region to region and from locality to locality.

Table 6.2. Mean Monthly Incomes and Expenditures by Income Group (in ETB)

Income Group	Annual per capita Income Range	Household Income			Fuel Expense			
		Mean	SD	Cv	Mean	SD	Cv	As % of the Income
Low	Below 5,001	1,517.65	418.75	27.59	265.70	66.89	25.18	17.51
Middle	5,001-10,000	2,824.53	909.84	32.21	314.32	69.53	22.12	11.13
High	Over 10,001	3,570.00	1,029.77	28.85	301.69	67.94	22.52	8.45
Average		2,315.09	1,076.08	46.48	290.15	71.82	24.75	12.53

Sd: standard deviation Cv: coefficient of variation

Source: Field Survey, 2014

The lowest monthly income for the sample households was 800.00 ETB, while the highest was 6,500.00 ETB per month. Mean monthly income for the sample households was 2,315.09 ETB. There is wide disparity in income among these groups, which can be explained by coefficient of variation of 46.48 percent. This disparity in income may have direct influence on the amount and type of energy resources consumed. Coefficient of variation is related to standard deviation. The coefficient of variation is informative, if it is given along with the mean and standard deviation; otherwise, it may be misleading. Variability can be assessed by examining the values of standard deviation which measures the amount of variability in the distribution of a variable. The standard deviation describes the standard amount variables differ from the mean.

There are also large variations in the pattern of energy requirements across households belonging to different income classes. At the same time, as can be seen from Table 6.2., the average monthly expenditures of households on various types of energy differ according to income levels. The average monthly expenditure on domestic energy per household was 265.70 ETB for the low, 314.32 ETB for the middle and 301.69 ETB for the high income groups. The average monthly fuel expenditure for the sample households was 290.15 ETB, which makes up 12.53 percent of the family mean monthly income. The lowest monthly expenditure for the sample households was 28.66 ETB, while the highest was as high as 455.81 ETB per month. The disparity in expenditure among sample households, which can be explained by coefficient of variation of 24.75 percent, is smaller.

As shown in Table 6.2 the average monthly income for low income households was 1,517.65 ETB. Most of the income values are confined between 1000.00 and 2000.00 ETB, the highest figure may go as high as 3,166.67 ETB and the lowest as low as 800.00 ETB. For the same group, the minimum expenditure is 28.66 ETB while the maximum expenditure is 389.87 ETB. The mean monthly expenditure on fuels was 265.70 ETB which constitutes 17.51 percent of the average households’ monthly income. This creates a higher financial strain on the budget of households of this income group. The standard deviation of 66.89 and coefficient variation of 25.18 percent shows that disparity in the expenditure on energy for the group.

The average monthly income for the middle income households was 2824.53 ETB with the minimum income of 900.00 ETB and the maximum income of 5000.00 ETB. The average monthly expenditure on various energy resources was 314.32 ETB with the minimum expenditure of 83.66 ETB and the maximum expenditure of 448.61 ETB. The coefficient of variation, which was 22.12 percent, shows that there was low variation in expenditure made on energy among households of this income group. The average monthly expenditure (314.32 ETB) constitutes 11.13 percent of the average income of the group, which shows the expenditure made on domestic energy has moderate strain on family budget.

In the high income group, the monthly income varies from minimum income of 1,000.00 ETB to the maximum income of 6,500.00 ETB with an average monthly income of 3,570.00 ETB. The highest value of expenditure goes as high as 428.41 ETB and the lowest was as low as 106.87 ETB. The coefficient variation of 22.52 percent reflects that there was low disparity in expenditure made by households of this group. The average monthly expenditure on fuels for this group was 301.69 ETB which constitutes 8.45 percent of the average income of the group, which shows as income rises; initially more fuel is consumed but less significant strain on household budget. High income households spent an average of 8.45 percent of their monthly income on the fuels; this figure was as high as 17.51percent for low income group.

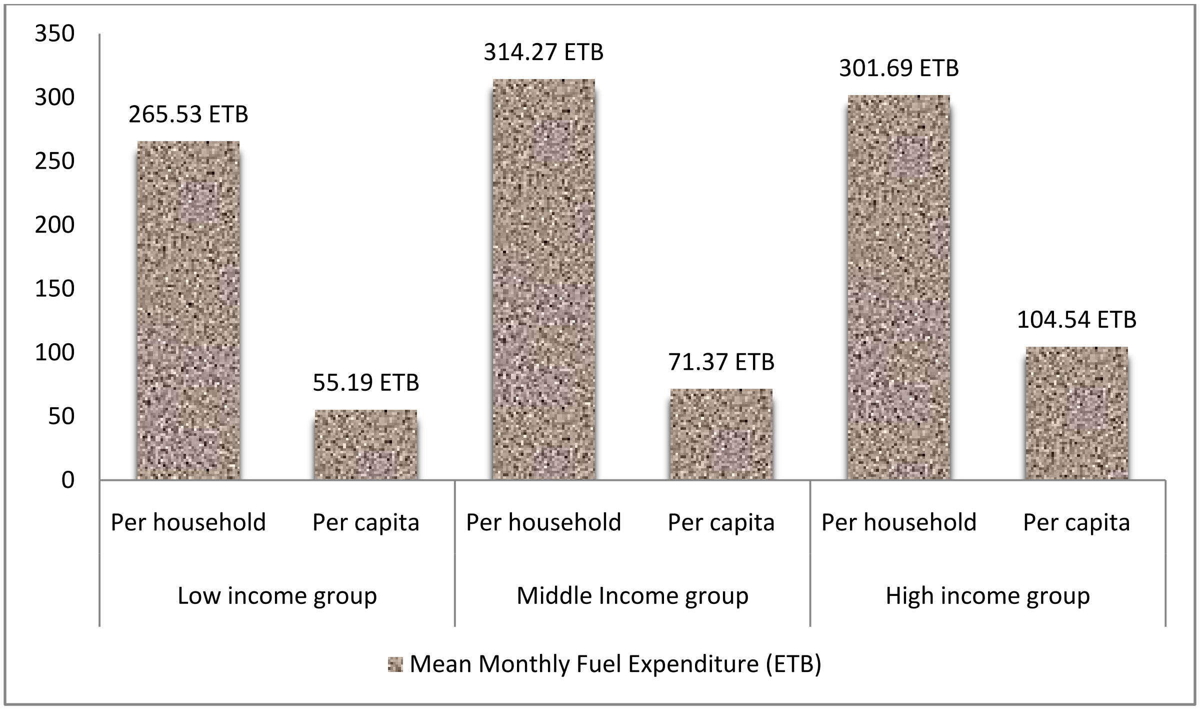


Figure 6.3. Mean Monthly Fuel Expenditure (ETB)

Source: Field Survey, 2014

Unlike the average monthly household expenditure, per capita energy expenditures made on domestic energy significantly increases with a rise in a family income. There is a progressive increase in average monthly per capita expenditure on all fuels consumed with the rise in family income. Mean monthly per capita energy expenditures for all sample households was 65.99 ETB and it varies from 55.19 ETB for the low income households to as high as 104.54 ETB for the high income households and mean monthly per capita expenditure on domestic energy was 71.37 ETB for middle income group.

According to Table 6.3., the most common energy source for low income people is biomass fuel while the higher income groups spend more on conventional fuels. Expenditure share of conventional fuels increases from 31.25 percent to 54.82 percent while that of the biomass fuels decreases from 68.75 percent to 45.18 percent as we move up from low income to high-income groups. The average monthly household biomass fuels use was 182.54 ETB for low income households. The figure falls to 176.81 ETB for the middle income households and 136.30 ETB for the high income households. Regarding the average per capita biomass fuels expenditures, the reverse is true. There is an increase in per capita expenditure on biomass fuels for domestic purposes as family income increases. The average monthly per capita biomass fuel expenditure was 37.8 ETB for the low, 41.06 ETB for the middle and 47.90 ETB for the high income group.

Table 6.3. Mean Monthly Expenditures on Fuels by Income Group (in ETB)

Fuel Type	**Low Income Households**		**Middle Income Households**		**High Income Households**	
	Per household	Per capita	Per household	Per capita	Per household	Per capita
Biomass fuels	182.54	37.80	176.81	41.06	136.3	47.9
Conventional fuels	82.99	17.39	137.46	30.31	165.39	56.64
Total	**265.53**	**55.19**	**314.27**	**71.37**	**301.69**	**104.54**

Source: Field Survey, 2014

On the other hand, the share of both the average household and per capita expenditures on conventional fuels in households' energy budget increases as we move from low to high-income groups. The average monthly household conventional fuels expenditure was 82.99 ETB for the low, 137.46 ETB for the middle and 165.39 ETB for the high income group. Similarly, the average per capita energy expenditures on conventional fuels by a family significantly increases with a rise in a family income. It was 17.39 ETB for the low, 30.31 ETB for the middle and 56.64 ETB for the high income group.

Households spend almost equal energy expenditure on charcoal and electricity. Expenditure on electricity (34.56%) and charcoal (31.56%) take lion's share of the fuel budgets. The result of the study conforms to that charcoal and electricity use cut across all income groups for the domestic function of cooking and lighting, respectively. Across income groups, the expenditures on sawdust and dry cell battery remain considerably low. The share of expenditure on each fuel varies considerably from household to household according to their income status. The share of expenditure on electricity constitutes 44.47 percent of fuel budget of high-income households, while the lower income households spend 23.98 percent of the same fuel. Generally, the low income households account higher proportion of biomass fuels (68.75%) as compared to other income groups in terms of expenditure. This is mainly due to less purchasing power for the lower income households and failing to make shift to other alternatives sources of energy so that they continue to spend more on biomass fuels (Table 6.4).

Overall about 56.73 percent of household energy expenditure is allocated to biomass energy while the rest (43.27%) was allocated to conventional energy. Average percentage of energy expenditure share for electricity, charcoal and fuel wood was 34.56 percent, 31.56 percent and 24.76 percent, respectively.

Table 6.4. Expenditure Share of Each Fuel Item by Income Group (%)

Income Group	Fuel wood	Charcoal	Sawdust	Kerosene	Electricity	Candle	Dry cell battery
Low	37.38	30.48	0.88	3.12	23.98	3.32	0.83
Middle	23.92	32.01	0.33	4.86	35.22	2.99	0.67
High	12.98	32.20	0.00	5.64	44.47	4.32	0.39

Source: Field Survey, 2014

Table 6.5 shows the relationship between average income and percentage of expenditure on fuel by households. For urban households, energy costs can form a significant part of household budgets however, the low income households, in general, pay more for energy than the high income households in relative terms. They spend a significant proportion of their limited income (17.50 %) on energy. High income households on the other hand spend 8.45 percent of their budget for the same purpose.

Budget share of expenditure on each fuel decreases with household income. For example, the high income households allocate 3.78 percent while the low income groups allocate 4.20 percent of their monthly income to electricity. On the other hand, low income groups allocate 6.54 percent of their budget to fuel wood while the higher income groups allocate only 1.10 percent of their budget. This implies that low income households are regarded as a high risk group of spending a great share of their incomes on fuel. They already pay more per unit of energy and consume less convenient forms of energy than the better off households. It was calculated that the low income households often pay more for wood fuels than they would for conventional fuels. The energy technologies most readily available to them are typically inefficient or low quality, so they end up paying much more per unit of end-use energy service.

Table 6.5. Budget share of Each Fuel Expenditure out of Household Income (in %)

Income Group	**Fuel Expenditure**							
	Fuel wood	Charcoal	Sawdust	Kerosene	Electricity	Candle	Dry cell	Total
Low	6.54	5.33	0.15	0.55	4.20	0.58	0.14	17.50
Middle	2.66	3.56	0.04	0.54	3.92	0.33	0.08	11.13
High	1.10	2.72	0.00	0.48	3.78	0.36	0.03	8.45

Source: Field Survey, 2014

6.3. Households' Gross and End-use Energy Consumption by Income Group

There is a tendency of decreasing in the consumption of biomass with the rise of the household income, while the consumption of electricity increases. Low income households used on average 66.68kg of biomass energy. This figure falls to 46.18kg for those high income households. Whereas per capita biomass fuel consumption increases proportionally with income, ranging from 13.78 kg for low income group to 16.27kg for high income group.

Table 6.6. Mean Monthly Consumption of Gross Biomass Fuels (kg) and Electricity (kWh) by Income Group

Fuel Type	**Income Group**					
	Low		**Middle**		**High**	
	Per household	Per capita	Per household	Per capita	Per household	Per capita
Biomass fuels (kg)	66.68	13.78	62.16	14.46	46.18	16.27
Electricity (kWh)	164.08	34.27	283.34	62.15	343.45	116.82

Source: Field Survey, 2014

Similarly, both household and per capita conventional energy increases with a rise in a household income. The average monthly per household and per capita consumption of conventional fuels varies widely across income groups. For example, monthly per capita electricity consumption was 34.27kWh for the low income households and 116.8kWh for the high income households. The average monthly kerosene energy consumed varies from 0.58litre for low income households to 1.19 liter for high income households (Table 6.6).

As shown in table 6.7., the mean monthly household gross energy consumption in terms of heat values delivered varies from 2002.79MJ for the low income group to 2,477.04MJ for middle income group with the average monthly household gross energy consumption of 2,251.96MJ for the sample households. On the other hand, with the rise of the household income, there is a significant proportion of increase in the mean monthly per capita consumption of energy in terms of heat value. The mean monthly per capita consumption of gross energy for the study area was 528.34MJ. It ranges from 415.37MJ for the low income households to 838.03MJ for the high income households.

Table 6.7. Mean Monthly Gross Energy Consumption (in MJ) by Income Class and Fuel Type

Fuel Type	**Low Income Households**		**Middle Income Households**		**High Income Households**	
	Per household	Per capita	Per household	Per capita	Per household	Per capita
Biomass fuels (MJ)	1,384.57	286.33	1,408.36	324.51	1,151.29	400.32
Conventional fuels (MJ)	618.22	129.04	1,068.68	234.16	1,285.04	437.71
Total	**2,002.79**	**415.37**	**2,477.04**	**558.67**	**2,436.33**	**838.03**

Source: Field Survey, 2014

The average monthly domestic biomass fuels consumed varies from the lowest (1,151.29MJ) for high income households to the highest (1,408.36MJ) for middle income households. On the other hand there is a proportional increase of per capita consumption of biomass fuels with income of the households. The average monthly per capita biomass fuels consumption varies from 286.33MJ for low income households to 400.32MJ for the high income households. Both the average household and per capita gross conventional fuels consumption proportionately increases with income of the households. The respective household and per capita gross conventional fuels consumption varies from 618.22MJ and 129.04MJ for low income households to 1,285.04MJ and 437.71.16MJ for high income households.

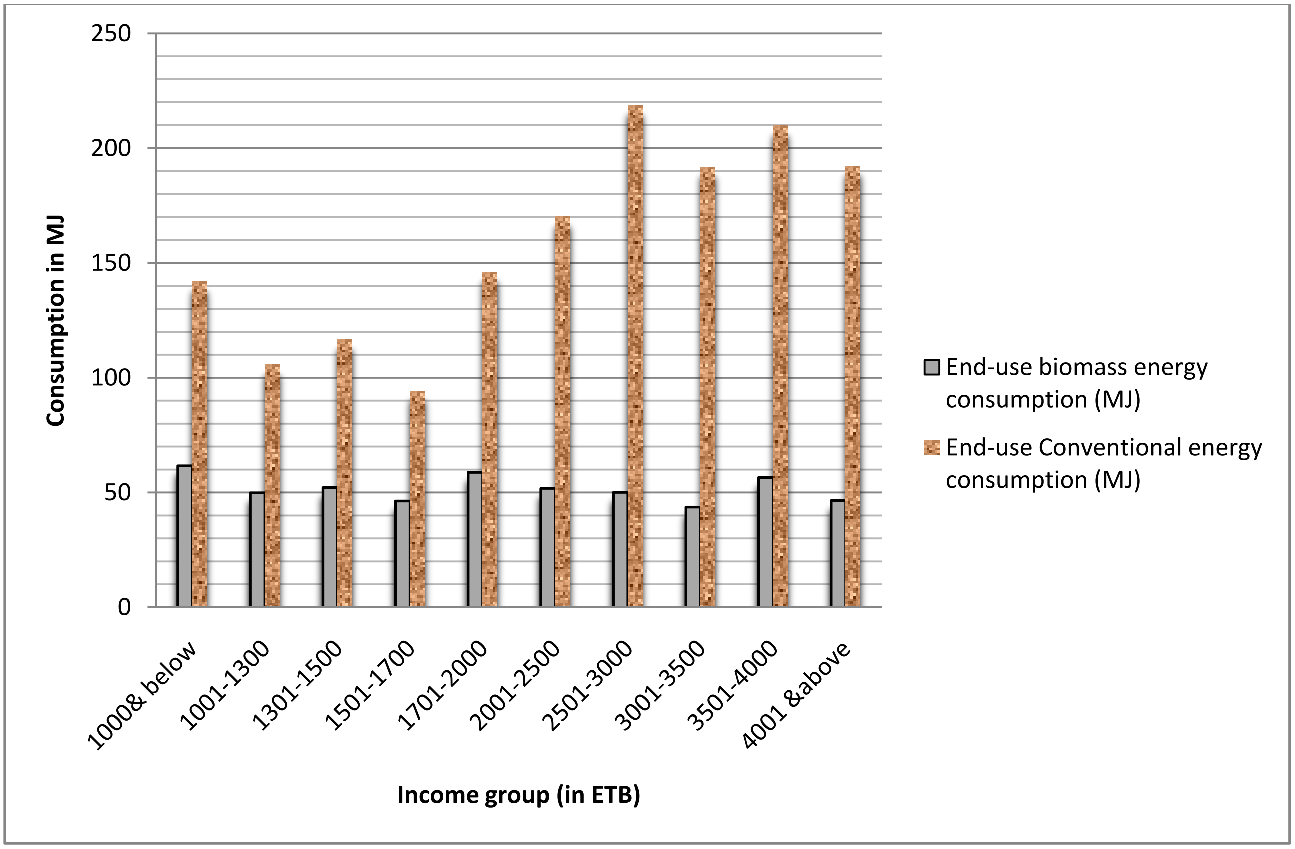


Figure 6.4. End-use Biomass and Conventional Energy Consumption (MJ) by Income Group

Source: Field Survey, 2014

Consumption of energy in terms of end-use energy utilized varies considerably from household to household. There is a corresponding increase for end-use energy consumption with a rise in a household income. The average monthly end-use energy received by a household ranges from 674.47MJ in the low income households to 1,160.55MJ in the high income households.

The amount of monthly end-use biomass fuel consumption varies from the lowest 216.79MJ for the low income to the highest figure 237.07MJ for middle income households, whereas the amount of conventional fuel consumption rises highly with income. It was 457.68MJ for low income households, and 790.32MJ and 952.97MJ for the middle and high income households, respectively. This is probably because as income grows households not only consume more biomass, but also modern fuels. While households with low levels of income depend almost entirely on biomass fuels for baking and cooking purposes rather they tend to switch to a multiple fuel-use strategy.

Regarding the average monthly end-use energy received, electricity has the largest share followed by charcoal and kerosene. The share of other fuels in the heat value of end-use energy is not important. For the low income group, the average monthly domestic consumption of electricity was 443.21MJ; this figure rises to 765.36MJ for the medium and 927.71MJ for the high income groups. Consumption of kerosene varies from 9.71MJ for the low income group to 17.95MJ for the middle income group and 20.01MJ for the high income group. Low income households receive 154.24MJ of charcoal, while the middle and high income groups receive 191.35MJ and 184.77MJ, respectively.

Table 6.8 Mean Monthly End-use Energy Consumption (in MJ) by Income Class and Fuel Type

Fuel type	**Low Income Households**		**Middle Income Households**		**High Income Households**	
	Per household	Per capita	Per household	Per capita	Per household	Per capita
Biomass fuels	216.79	44.86	237.07	54.2	207.58	71.53
Conventional fuels	457.68	95.55	790.32	173.24	952.97	324.51
Total	**674.47**	**140.41**	**1,027.39**	**227.44**	**1,160.55**	**396.04**

Source: Field Survey, 2014

Mean monthly per capita candle energy consumed varies from 0.75MJ for low income households to 1.87MJ for middle income households. Biogas per capita consumption ranges from nil for high income group to 1.87MJ for middle income households. Monthly per capita dry cells consumption was almost nil for all income households. Despite the fact that the majority of middle and higher income households combine the use of biomass fuels with other clean source of energy particularly kerosene to satisfy their cooking needs, wood fuels remain the dominant fuel among the lower income households. The detail information on gross and end-use household energy consumption by income group (MJ) is shown in annex 8.

Table 6.9. Share of Household and Per capita End-use Energy (MJ) out of the Total Input Energy (MJ)

Income Group	Gross Energy(MJ)		End-use Energy(MJ)	
	Per household	**Per capita**	**Per household**	**Per capita**
Low	2,002.79	415.37	674.47	140.41
Middle	2,477.04	558.67	1,027.39	227.44
High	2,436.33	838.03	1,160.55	396.04

Source: Field Survey, 2014

The amount of end-use energy received by a household rises with an increase in household income. The households of the lower economic levels receive less amount of end-use energy as compared to households in the high economic levels. A household in the low income group receives 33.68 percent of its gross energy input, while that of medium and high income groups receive 41.48 percent and 47.64 percent, respectively (Table 6.9). This indicates that with a rise in a household income, there is a tendency for households to use better fuels that are used at high efficiency level by employing modern appliances for baking and cooking. The detail information on the share of end-use energy consumption out of the total gross energy consumption by income class is shown in annex 9.

6.4. Utilization of Fuel Using Technologies by Income Class

Different income groups have varying requirements for energy use and, as income rises, they meet their needs with different energy sources and conversion technologies. As indicated in Table 6.10, as the income of the household increases, the percentage of open fire stove users for *Injera* baking decreases while the percentage of electric baking appliance users increases. Out of the total electric baking appliance users, the proportion was 11.86 percent for the low, 55.93 percent for the middle and 32.20 percent for the high income groups. The proportion of households using *Lakech* stove is higher and almost similar among the low and middle income groups whereas the proportion of households using kerosene stove is higher among the middle income groups.

Low income households often have a limited choice of technologies that convert energy to useful services. The technologies most readily available to them are typically inefficient or low quality. They are most likely to suffer the health effects of energy inefficient appliances. Households in the lower economic status receive less amount of useful energy due to low efficiency of energy utilization as compared to household of high economic status. The use of biomass fuels and simple appliances in the lower economic strata group makes them to consume low amount of household end-use energy to meet the fundamental energy needs particularly cooking and baking.

Table 6.10. Ownership of Baking/ Cooking Appliances by Income Group

Baking/Cooking stove	**Low Income Households**	**Middle Income Households**	**High Income Households**
Open earthen (three stones) stove	259	151	11
Traditional Iron charcoal stove	45	18	nil
Mirt baking stove	11	24	21
Lakech charcoal stove	192	222	91
Kerosene wick stove	37	77	51
Electric *Injera* baking stove	21	99	57
Electric cooking stove	3	24	34
Biogas cooker	6	11	nil
Total	**574**	**626**	**265**

Source: Field Survey, 2014

6.5. Energy Poverty and Low Income Residents

Until recently poverty was synonymous with rural conditions, but the rapid urbanization of many developing countries has given birth to a large class of urban poor who are directly affected by variations in food and fuel prices and income (DFID 2011). A disruption in the flow of income for an urban household means lack of access to adequate levels of food, water, clothing, shelter, sanitation, health care and education (Reddy 2004).

Karekezi *et al.* (2002)reported that income is an important indicator to identify which people are likely to lack the resources to achieve a socially acceptable standard of living, the distribution of urban and peri-urban income in Kenya, for instance, shows a large disparity between the poor and the non-poor. This section highlights the two way linkage between energy poverty and low income residents. Household income is generally the preferred measure for analysis of people's economic well-being. This is because the major determinant of economic well-being for most people is the level of income the household obtain.

In a study conducted by Drexler (2004), it was shown that the term "energy-poverty nexus" can be used to describe the complex interplay between the inadequate energy situation and the miserable socio-economic living conditions faced by most people in developing countries. The urban poor may have even greater problems with fuel scarcity as their incomes have not kept pace with the rising prices. Pachauri and Spreng (2004) noted that access to energy services can be limited by the purchasing power of the household, the cost of energy and cost of energy using equipment. In a study conducted in India by TERI (2010), it was shown that income poverty acts as a deterrent to households in acquiring cleaner fuels and there is a vicious circle of energy and income poverty, wherein income poor are unable to afford high priced modern fuels thereby aggravating energy poverty concerns.

This is indeed a problem of the vicious cycle of energy poverty: lack of energy affects the economic activities of households and in turn limits their ability to make use of energy services. To better understand the energy poverty, the Institute for Development Studies (IDS) (2003) analyzed its vicious circle (see Figure 6.5).

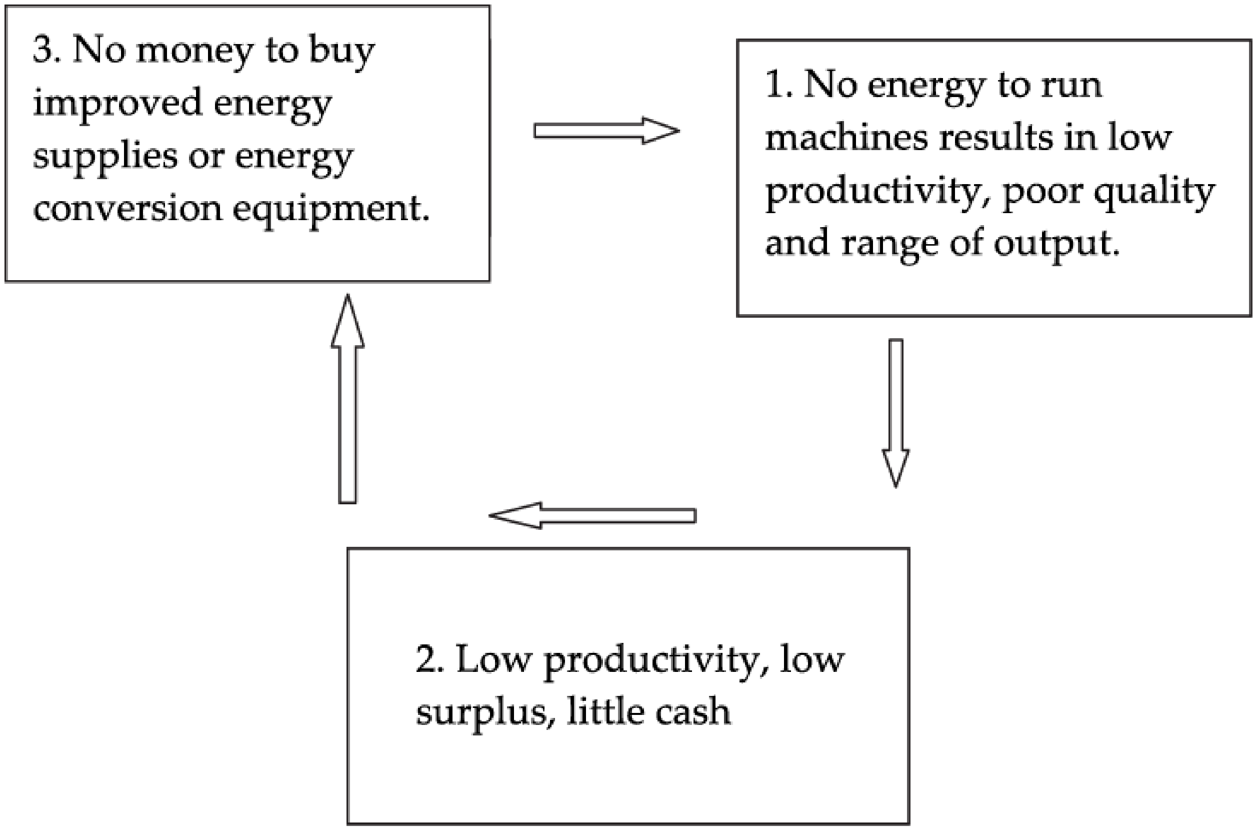


Figure 6.5. The vicious Circle of Energy Poverty

Source: Institute for Development Studies (2003)

This paper considers expenditure-based approach to identify the basis of calculating the energy poverty line in the study area. In this section we estimate the existing measures of energy poverty by employing expenditures as a proportion of total income. This can be done by determining energy use as a function of income, and by calculating the average level of energy use corresponding to an amount of income.

A household is said to be in energy poverty if it needs to spend more than 10 percent of its income on energy. Such a cutoff point of 10 percent is frequently mentioned in literature as common level of identify the basis of calculating the energy poverty line (Pachauri and Spreng 2004). Boardman (2010) asserts that urban income is one of the strongest influences on household energy choice.

Thus, here in this study an average household income can be used as an indicator for the monetary well-being of a household and the situation of energy poverty among urban and peri-urban households is analyzed based on household energy spending to identify whether households are energy poor or not.

Energy as a percent of total expenditures is often well above 10 percent of their income. A household is considered to be in energy poverty if over 10 percent of its disposable income is spent on energy. Accordingly, the results indicate that the majority of the sample households (72.9%) face burden of energy poverty and often end up spending a substantial proportion of their household income on energy. It means that households have little or no access to conventional energy sources rather they are dependent on biomass energy sources to meet their baking and cooking requirements.

More than half of the surveyed households (59.38%) are from low income households, 34.79 percent are from middle income households and only a minority (5.83%) is from high income households. It was found that the problem of energy poverty is acute among the low income households as people with less income have limited access to clean fuels. Out of the total 423 lower income residents, the majority (92.2%) are energy poor while only the rest (7.8%) are non-energy poor. This implies low income households continue to suffer as their incomes have not kept pace with the rising prices and face high burden of energy poverty as they tend to spend a larger share of their income on purchasing wood fuels. The higher price elasticity for fuels affects adversely all consumers but most critically the low income households. Wood fuel prices in urban markets often rise rapidly as wood resources are seriously depleted in the study area, thus the energy poor are still inadequately served by energy supplies and, thereby undermining their livelihoods. It is indicated that households who spend more on biomass energy are more likely to be energy poor than those who spend less on biomass energy. That means higher conventional energy expenditure by households implies that these households have opportunities to buy more types and amounts of modern energy and use different modern energy appliances (Figure 6.6).

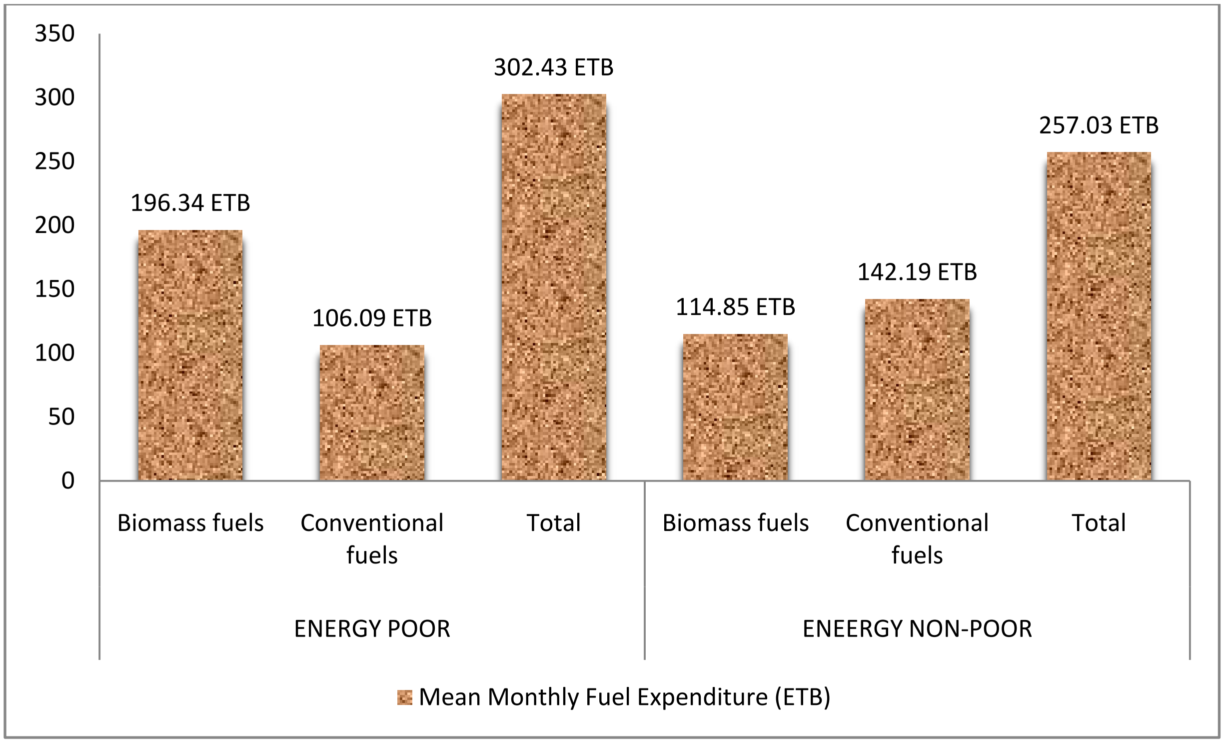


Figure 6.6. Mean Fuel Expenditures (ETB) of Energy-poor and Energy Non-poor Households

Source: Field Survey, 2014

As can be seen from Table 6.11., energy poor households predominantly depend on biomass fuels with mean monthly consumption of 242.32MJ which is higher when compared to the consumption by energy non-poor households (174.08MJ). While energy non-poor households, on an average, consume 845.42MJ of conventional energy compared to the consumption by energy poor households (587.32 MJ). The evidence presented in this section suggests that end use energy is clearly a better measure of energy poverty. Energy poverty declines as people adopt more modern forms of energy.

This implies that the end-use energy consumption level of energy poor households lowers as they tend to stick to consumption of biomass fuels. Moreover, since many households cannot afford modern energy sources, a substantial portion of the urban low income households resort to wood fuels. This indicates the growing level of energy poverty in the area which needs to be addressed at the earliest. This lends itself to conclude that household well-being, income, and energy use are jointly determined. Although making the switch to electricity offers many possibilities, many households could not gradually diversify their electricity use. As a result, their energy poverty situation remains unimproved. It is therefore likely that such limited use of conventional fuels and significant reliance on biomass fuels deter opportunities of most residents for economic and social advancement. Access to energy alone is not enough to combat poverty, says UNDP report (2011), the poor need support to generate income so that energy becomes affordable, which in turn will improve household living standards.

Table 6.11. Mean Monthly Gross and End-use Energy Consumption Patterns of Energy-poor and Non-poor households in MJ

Consumption Type	**Energy Poor Households**		**Energy Non-poor Households**	
	Gross Energy (MJ)	End-use Energy (MJ)	Gross Energy (MJ)	End-use Energy (MJ)
Biomass fuels	1,503.48	242.32	988.35	174.08
Convectional fuels	793.28	587.32	1,142.79	845.42
Total	2,296.76	829.64	2,131.15	1,019.51

Source: Field Survey, 2014

The findings suggest that growth and adoption of efficient cooking stoves use can lower energy poverty. Thus, there is a need to improve the status of households by enhancing their access to modern energy sources and related stoves in view of the fact that reducing energy poverty can help reduce income poverty as well. It is necessary to understand the composition of energy used by both energy poor and non-poor households. Table 6.12., presents an interesting contrasts in the energy use pattern between energy poor and energy non-poor households. As shown in the, it is the level of electricity consumption that separates energy poor and non-poor households more than any other sources. Overall, the energy poor households consume 210.80kWh of energy per capita per month, compared to 303.30kWh used by the energy non-poor households, implying that energy non-poor households have access to clean cooking energy and use different energy appliances, thus benefiting from modern energy supply.

Table 6.12. Mean Monthly Gross and End-use Energy Consumption Patterns of Energy poor and Energy Non-poor Households in kg and kWh

Household Type	Per capita Income (ETB)	Biomass Fuels (kg)	Electricity (kWh)	Kerosene (lt)
Energy-poor Households	757.12	69.95	210.80	0.83
Energy Non-poor Households	1,887.43	41.27	303.30	0.94

Source: Field Survey, 2014

CHAPTER SEVEN

7. FACTORS IN THE UTILIZATION OF HOUSEHOLD END-USE ENERGY

This chapter discusses the reasons for household preferences of energy sources and related energy using devices. The next section of the chapter was concerned with the determinants of biomass and conventional end-use energy consumption among urban and peri-urban households.

7.1. Households' Preferences for Fuels and End-use Equipment

Energy has been the basic necessity of all household. A detailed survey of the preferences and attitudes of consumers with regard to fuel resources and related stoves could be able to assist in developing urban energy strategies as a solution of sustainable energy services in urban and peri-urban areas. Hence it is important to look into households decisions regarding energy consumption and explore factors that underpin their choices of one source of energy over other fuels.

The study reveals that biomass fuels are the most highly consumed energy sources for the purpose of baking and cooking. This leads to raise a question that why is electricity not preferred for baking and cooking by the households despite its presence. The current study found that reliable supply was the main reason for the decision to adopt fuel wood (54.3%) and charcoal (29.46%). 41.10 percent of those who were interviewed prefer to use wood fuels mainly due to reliable supply and nearly a quarter of the respondents (24.62%) considered wood fuels as relatively cheaper compared to other conventional energy sources. Urban and peri-urban households meet their demand mainly from the nearby forests.Talking about this issue an interviewee from peri-urban area said: *"Fuel wood is readily available because of our proximity to the forest. We are assured of a constant supply of charcoal at affordable prices"*.

The type of foods being cooked plays a significant role in fuel use. According to some respondents the type and taste of foods and drinks prepared also determines what type of fuel to use. Good taste of food and quality of the food prepared (17.4%) was also the concern of households for the choice of wood fuels. The taste imparted to particular foodstuffs by wood fuels is a common reason for not switching away from biomass fuels.For example, households prefer to use wood fuels instead of conventional fuels to prepare certain type of local foods and drinks (*Kurkufa, Fossesie and Cheka*). For the preparation of such food and drinks many households prefer wood fuels as these fuels ensure good taste and flavor. Fuel wood is the most preferred for this purpose by all income groups. A 34 year old woman petty trader expressed her view by stating that "*wood has more advantages over charcoal for the preparation of Kurkufa and Cheka. I do not use charcoal to prepare such local foods. It is because using charcoal takes a long time to cook and pots not fitting charcoal stoves. It is difficult to put the cooking pot on the charcoal stove or gas burner and stir it with one hand but the moment you place it on wood stove, it becomes easy*". The most important reasons that can be considered to be significant for households' decisions to regularly use wood fuels are presented in Figure 7.1.

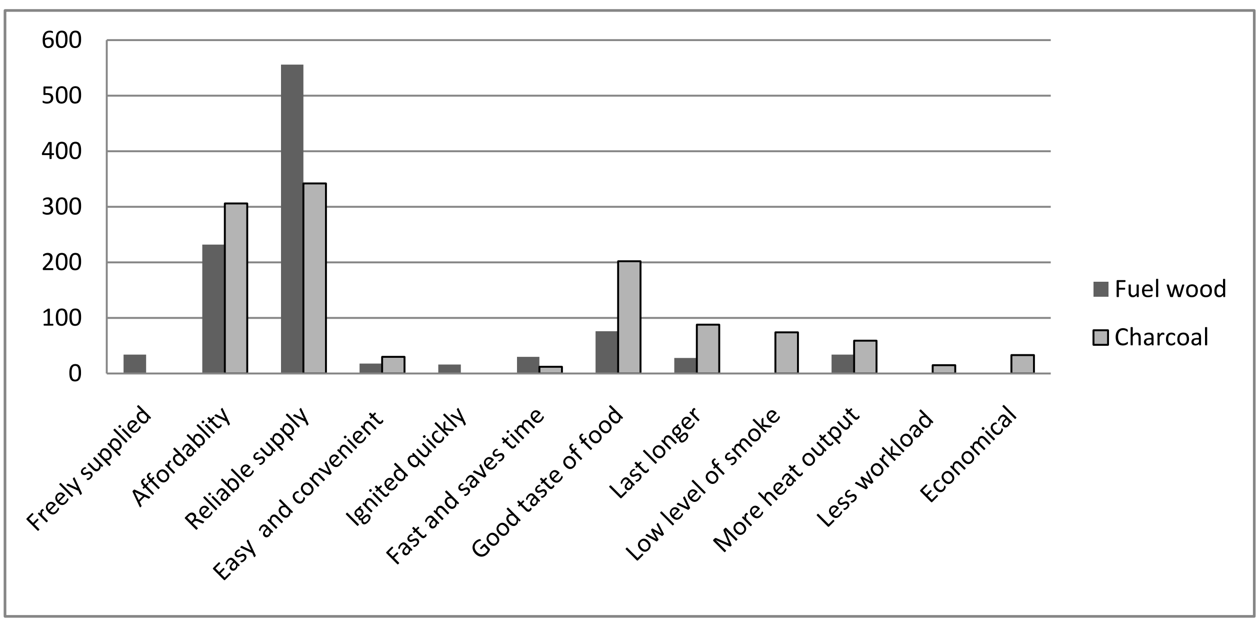


Figure 7.1 Number of Households using Wood fuels

Source: Field survey, 2014

Access of electricity is not considered as a problem, yet only a quarter of the surveyed households (26.9%) rely on electricity to cook. Most of the households interviewed would prefer to use electricity if they could afford the cost of the fuel and related appliances.

Specifically those who have experiences in utilizing electricity for cooking have been asked if the tariff has affected their consumption. Five hundred sixty three sample households, who have their own meters, have been asked their perceptions about the price of electricity, most residents in urban and peri-urban areas were much more inclined to the feeling that they are paying high for electricity. Almost three-quarters (73.5%) are of the opinion that they are paying high for electricity. Just under a quarter (22.4%) felt they pay about the right amount for what they receive. Very few (4.1%) said they pay low. On the other hand, the study reveals that conventional fuels (electricity and kerosene) are most preferred due to their characteristic of being convenience and clean as well as they can make food preparation faster despite cooking with these fuels is only practiced by limited number of households.

The amount of time spent by households to prepare biomass fuels for cooking was found to be of great concern. Moreover, the heavy work on cleaning utensils and houses caused by burning firewood has been one of the major problems for women. It took a considerable time for them in cleaning the houses, dishes and linens as they frequently covered or marked with dirt or an unwanted substance while cooking with wood fuels.

The majority of electricity and kerosene using respondents indicated that cooking with these fuels means significant time savings compared to biomass fuels especially when used to prepare food. Pots and other kitchen equipment do not get stained with soot so much, and time is therefore saved on their cleaning.

Households' choice of electricity and kerosene is dependent on factors such as allowing speedy cooking and time saving for electricity (20.27%) and for kerosene (16.97%). Other major reasons for the choice of electricity are less workload (15.57%), easy and convenient (14.09%) and low level of smoke (13.84%) while reasons such as being economical (16.05%) and more heat output (14.34%) were the concerns of households for the choice of kerosene.

Many of those interviewed preferred kerosene over charcoal because it is strongly linked to time saving particularly for preparing quick meals such as tea or for heating food or water. It cooks faster than any other heating fuels. A woman household head, 38, stated: *"Using kerosene makes it quicker for me to prepare food. It allows food to be prepared on time. I use kerosene when I am in hurry or if want to warm food"*. The most important reasons that can be considered to be significant for households' decisions to regularly use conventional fuels are presented in Figure 7.2.

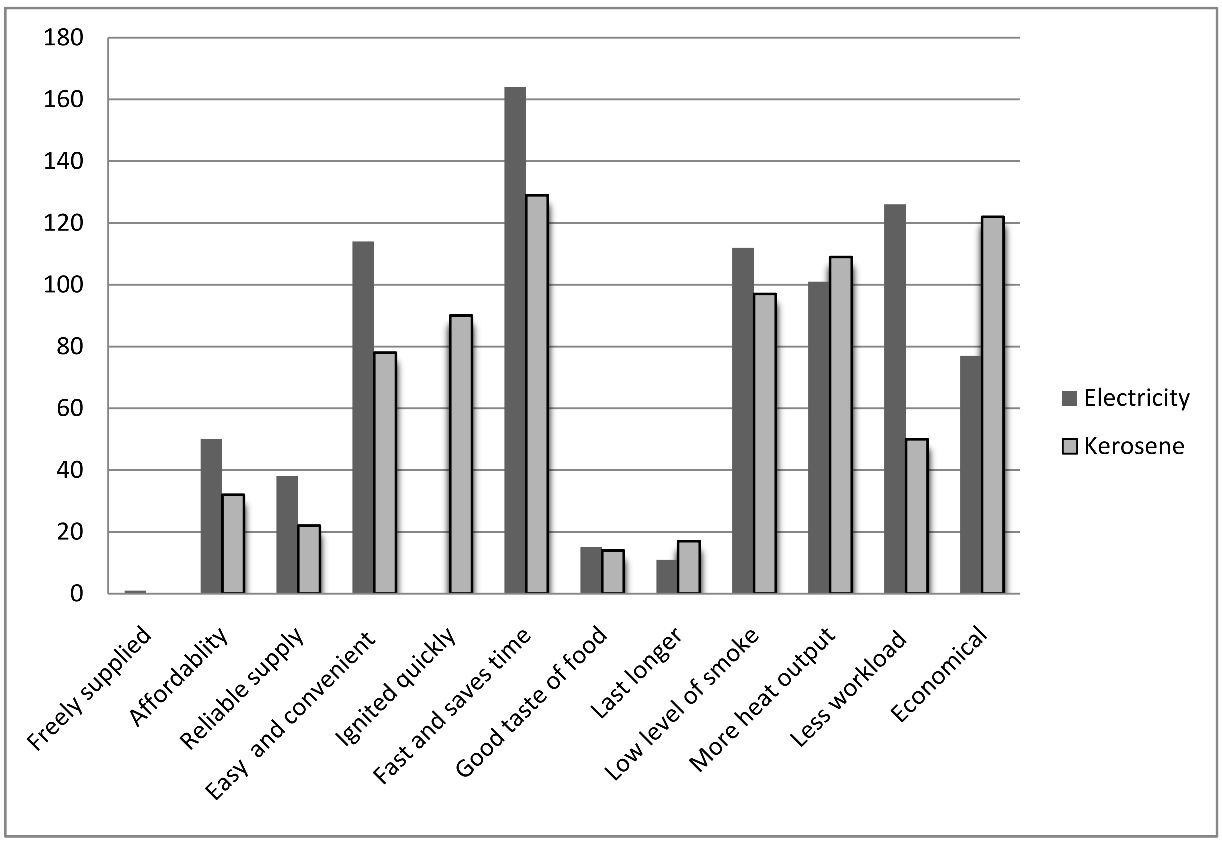


Figure 7.2. Number of Households using Conventional Fuels

Source: Field survey, 2014

Using conventional fuels can reduce the overall workload of women and have health benefits. On this point, one woman informant states, *"I cannot continue to use firewood to bake Injera due to the hazardous smoke and heat. I need an alternative because I think I cannot continue due to the health problems which I am likely to suffer from as a result of the continuous exposure to smoke and heat".* Another woman stated that she prefers kerosene to charcoal because the latter generates indoor smoke and creates inconvenience.

The study found that physical access to conventional energy source is hampered by frequent shortages of LPG. The unpopularity of LPG in the area is more accounted for its limited availability and irregularity of supply compared to other fuel sources. According to the respondents, it is hard to find LPG on the nearby market. Even households that are willing and able to pay simply will not make the switch from charcoal to LPG as the gas and cylinders are not consistently available at local level. Currently sample households surveyed had no mention of using LPG because of difficulties in obtaining it possibly due to the high initial cost of purchasing cylinders. Thus they want to use charcoal to offset the supply inadequacies associated with gas.

Despite the fact that LPG is being more clean, economical, and convenient to use, its access is very difficult due to the low purchasing power of most urban and peri-urban households. Only small number of sample households had experience of this fuel, but most have stopped utilizing LPG due to the scarcity and increase in price per cylinder. The overall cost of a cylinder with its related accessories has greatly affected the dissemination of LPG. As a 35 years old man commented: "*Gas burner is expensive to be able to buy. It is very expensive."*A small number of respondents (11%) explained that they never used LPG for safety reason that it is a dangerous fuel causing accident in life and property. Talking about this issue a female head interviewee said: "*I do not have knowledge as to how to safely use. For the sake of our children, my family does not use this gas*".

It was also found that there were very minimal households who responded that kerosene was either unavailable or inaccessible but the high cost of kerosene was considered as a problem. Majority of the households that rely on kerosene explained that relative to their income, cost of kerosene is expensive.

Key informants from peri-urban area informed that biogas is the preferred option for those who can install it as it is the most convenient, least polluting and most efficient fuel for cooking and that the use of biogas can benefit to the health conditions of the household members, in particular, women who are most beneficial as they are very often responsible for managing the fuel. Talking about this issue an informant said: "*By producing and using biogas in our home we no longer have to burn charcoal for cooking. It significantly reduces eye infections and respiratory illness that was common to my wife when using biomass fuels*, therefore, *her health was improved now*". Another female head, 32, stated: "*Biogas is a clean burning fuel and has a significant health advantage over wood fuels. Cooking is smokeless and my kitchen is now free of smoke and ash.*"

Focus group discussion with households revealed that there are households who preferred not to use electricity for baking and cooking purposes due to high electricity tariff and associated cost of end-use devices. When asked about the reasons why electricity is not used for cooking purpose, almost all the non-adopters responded they cannot afford to spend on electric baking stoves. Affordability problem is a major constraint for most households from buying appliances. The limited budget of households constrains them to buy the appliances whose prices they consider to be above their budget. Only a quarter of the sample households were found to have adopted the electric baking stoves. These urban households have changed their energy consumption from using woody biomass to modern energy fuels by installing electric baking stoves.

Attempts have been made to know the perception of the sample respondents about the stoves they are utilizing. The study looks into what influences household's decision to purchase and use the devices. For example, more than three fourth of traditional three-stone open- fire baking stoves and *Lakech* users (77%) said it is because they are easily available in the nearby market and in local stores.

Figure 7.3 shows the different reasons informing the choice of *Injera* baking stoves used by the respondents. Affordability was the main reason for the decision to adopt traditional clay made baking stoves. More than half of traditional three- stone open- fire baking stove (52.25%) said that this end-use energy device has low cost compared to other baking stoves. The second reason is its easy availability (32.31%) followed by good taste of food prepared (15.44%). Only small portion of sample households (12.08%) use electricity for baking *Injera*. Expensiveness is the main reason identified for the limited use of electric baking stoves, despite the fact that a majority of sample households used electricity at home.

Whereas saving fuels (35.71%) and low level of smoke (28.57%) were the concern of the respondents for the utilization of *Mirt* stoves. The main reasons relating to the choice of electric baking stove are fast cooking and saves time (20.0%), low level of smoke (18.93%) and high heat output (17.97 %). Other reasons relating to issues such as minimizing workload represent 16.79 percent whilst being convenient to use was the concern of 14.87 percent of the respondents.

The fact that the cost of electric baking and cooking stoves, which are beyond the financial capacities of many households, has led them to stick to fuel wood and charcoal other than electricity. A female head mentioned high electricity tariff as the main reason not to use her electric baking and cooking stoves. As she pointed out: "*It is unable to me to use the electric baking and cooking stoves in my room simply because I cannot afford to pay the bill*". Another woman, having five family members, revealed that initially she used a three stones stove and an electric baking stove alternatively. But the electricity fee was too much for her to pay therefore she made a decision to shift to fire wood and use only three stones stove which she thought is economical to meet daily basic baking and cooking requirements.

Almost all sample households owning *Mirt* baking stoves, consider such stoves to be convenient and clean when compared with the traditional three- stone open- fire baking stoves. As one woman interviewee said: "I *fortunately bake Injera every day without the health hazards and with low fuel consumption. Since I started to use the Mirt baking stove, my health has improved significantly. When using Mirt baking stove, it significantly saves my time since it enables me to cook Wot simultaneously with Injera baking on the same stove without additional need of fuel wood*".

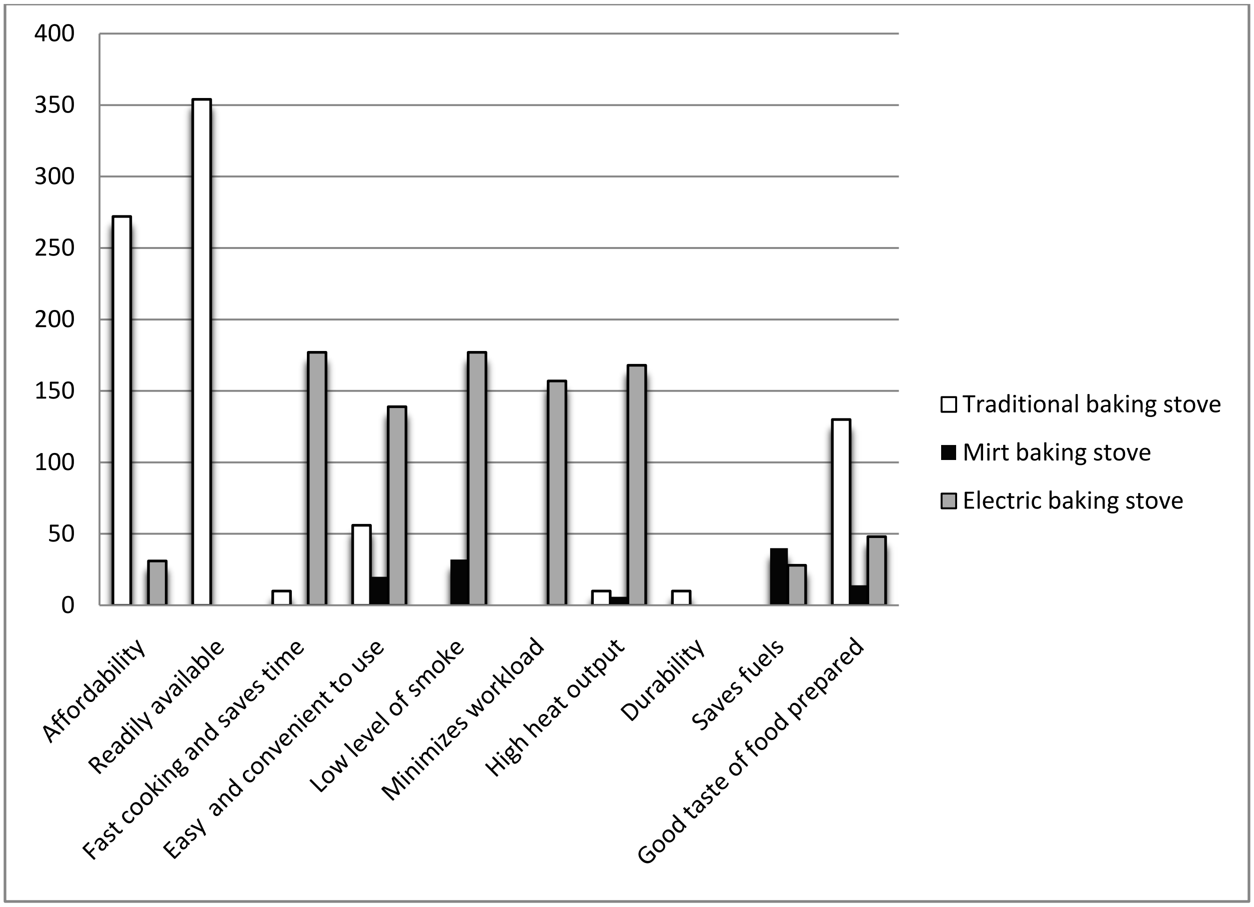


Figure 7. 3. Number of Households using Baking Stoves

Source: Field survey, 2014

The most important reasons for using *Lakech* stove in the survey area are availability and affordability of the stove compared to electric, kerosene and LPG stoves which are often more expensive. Readily available was the main reason for the decision to adopt *Lakech* stove (34.27%), followed by affordability of the stove (21.98%) and saving fuels (16.24%). Long slow cooking was also another major reason for the widespread use of *Lakech*. Using charcoal with *Lakech* lasts longer before it cools down. 77percent of the households prefer *Lakech* stove other than kerosene for food items which need slow cooking.

While reasons such as fast cooking and saves time (24.08%) and low level of smoke (20.94%) were the concern of kerosene stove using households. It is usually more cost effective and economical to purchase kerosene than fuel-wood as underlined by a 30 year old female interviewee who states "*Kerosene is cost effective. When I buy 5lt of kerosene for 75 ETB, I could use it for two-three months but when I buy a sack of charcoal for the same amount it will last for a month*". Electric and kerosene stoves using households prefer such stoves as they allow control of heat output when cooking takes place. The cooker is able to turn the valve on and off for a better control over the heat source, thereby he/she can save money. The most important reasons that can be considered to be significant for households' decisions to regularly use cooking stoves are presented in Figure 7.4.

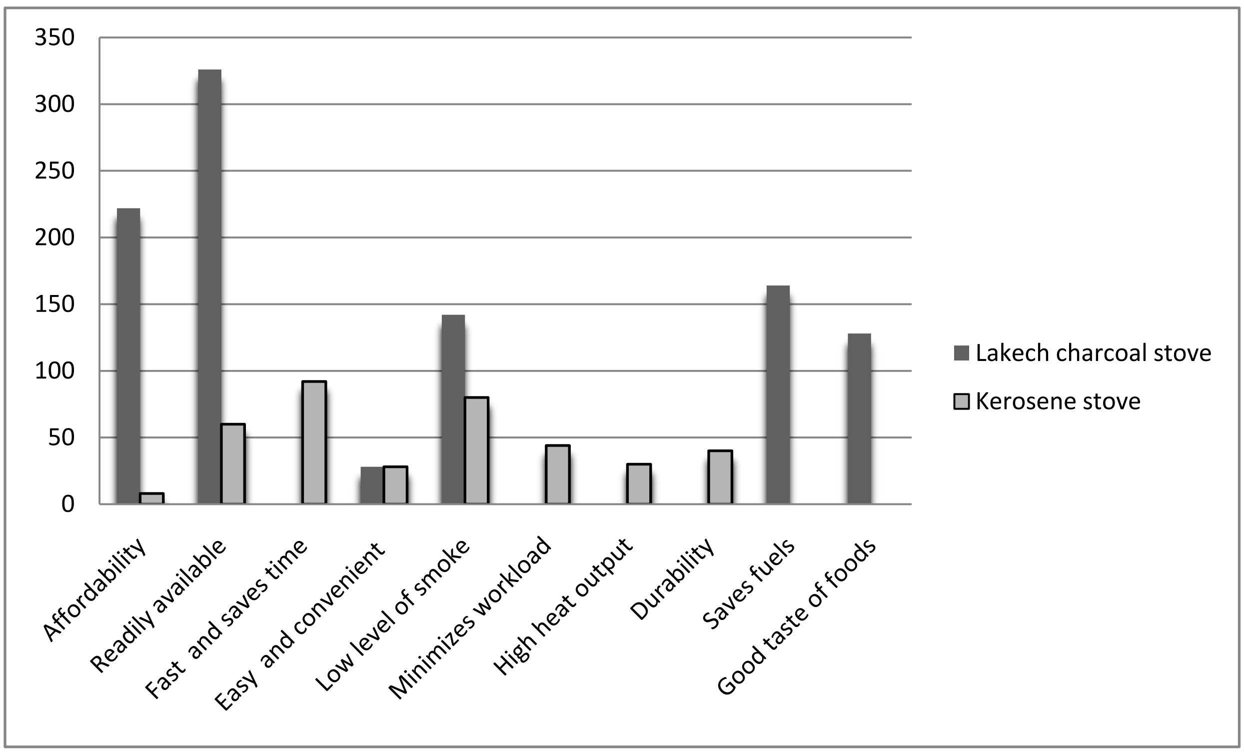


Figure. 7.4. Number of Households using Cooking Stoves

Source: Field survey, 2014

Availability and low price of stoves are major reasons for more use of biomass fuels by a large majority of households. Most households cannot afford modern cooking fuels and appliances because they are too expensive for them. Most urban households cannot easily make a transition from biomass to electricity for cooking end-use since the high costs of modern cooking stoves are major constraints for them. For this reason many urban households of the study area are unable to change their cooking energy consumption from using woody biomass to conventional fuels. This implies that the majority households lack the ability to optimize their consumption through improved technologies, thus no significant switching from wood to electricity.

Like for cooking, the study probed the reasons for selecting the different energy options for lighting. According to the survey findings, it appears that affordability was a key factor for selection of electrical bulbs followed by durability, brighter and prolonged light, and save power. 90 percent of the energy used for the incandescent bulb is emitted as heat rather than light, making this bulb the least efficient. Light from fluorescent lamp is of a superior quality and it generally uses 75 percent less energy than incandescent light bulb. It is also long-lasting product, with a lifetime of 10,000 hours (EEU 2012).Brightness was the main reason for preferring compact fluorescent bulbs (40.54%), followed by saving power and reliability of the bulb (24.61%), and its availability (17.27%). while affordability (27.97%) and ease of use (23.67%) were cited as the main reasons for choosing incandescent bulbs. Figure 7.5 portrays the reasons for household’s choice of lighting appliances.

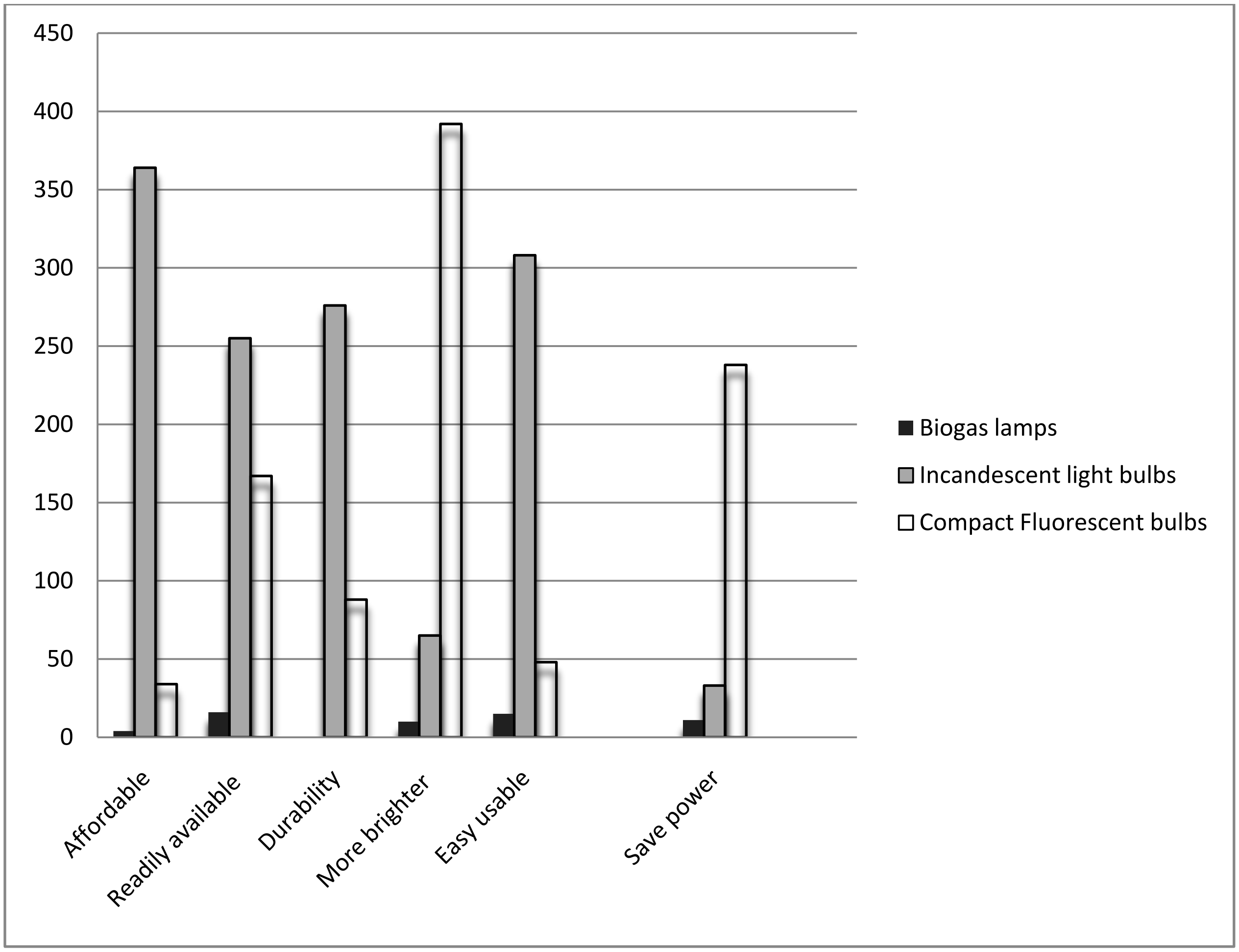


Figure 7.5. Number of Households using Lighting Appliances

Source: Field survey, 2014

7.2. **Factors Affecting End-use Biomass and Conventional Energy Consumption**

The survey analyzed household end-use fuel consumption as a function of several explanatory variables. Variables such as age, sex, education level, occupation status and marital status of the head of the household, household monthly income, expenditure made on fuels, household size, ownership and quality of residential housing units, availability of proper kitchen, and possession and utilization of end-use equipment are important as regards to explaining household's decision to consume a particular fuel.

In the present study the variable of interest is end-use household energy consumption in terms of heat value (MJ). According to DeCoster (2004) for a dichotomous categorical variable and a continuous variable you can calculate a Pearson correlation. This correlation is then also known as a point-biserial correlation coefficient. Becketti (1994) noted that it is common the Pearson correlation formula can be used to measure the relationship between two variables when one or both of the variables is dichotomous. To do so, Assign numerical values to the categories of the dichotomous variable(s) and then use the regular Pearson correlation formula to calculate the correlation.

The point-biserial correlation coefficient is a special case of Pearson product moment correlation applied to dichotomous and continuous variables, it is mathematically equivalent to the Pearson in which one variable is quantitative and the other variable is binary or dichotomous and nominal (NCSF 2012). DeCoster (2004) suggested that the easiest way to get the point biserial coefficient is to compute the Pearson. So computing point-biserial correlation is equivalent to computing the Pearson correlation.

For the more rigorous analysis, the study used linear multiple regression to explain the relationship between a linear combination of the independent variables and dependent variable which is assumed to follow normal distribution. The model uses the ordinary least squares solution to construct a linear model that minimizes error in predicting the end-use energy consumption. It describes a line for which the (sum of squared) differences between the predicted and the actual values of the dependent variable are at a minimum.

A functional relationship was formulated to ascertain the determinants of end-use household energy consumption using correlation matrix which gives an overview of the pattern of relationships between the amount of consumption of end-use energy (dependent variable) and other independent variables (annex 12). High correlation should be detected between two predictor variables as it causes problems when trying to draw inferences about the relative contribution of each predictor variable to the success of the model. The coefficient correlation matrix of the model estimate was evaluated and multicollinearity could not make significant impact on the quality and stability of the fitted regression model. The exogenous variables not highly correlated either. The highest value recorded between sex and marital status (0.786) was acceptable.

Variables such as household income, fuel expenditure, age and occupation of the head, ownership of electric meter and number of non-cooking electrical appliances were positively and significantly related to monthly consumption of household biomass end-use energy, while only quality of kitchen was negatively and significantly related to it.

On the other hand, end-use consumption of conventional fuels is positively and significantly related with all the stated independent variables except family size and number of traditional cooking stoves which were computed to be negative and significant in relation to end-use conventional energy consumption.

There is a corresponding increase in the amount of household biomass and conventional end-use energy consumption with an increase in household income as a whole. According to Table 7.1household income has a significant positive effect on the probability of choosing conventional fuels as a cooking fuel over biomass fuels. The value of correlation coefficient, which is 0.100, shows an increase but not strong enough impact of income in the amount of household biomass end-use energy consumption. The amount of biomass end-use fuels consumption declines with the rise in the income of the household. Low income households tend to purchase low quality fuels because they have low purchasing power. On the other hand, the value of correlation coefficient for the conventional end-use energy consumption, which is 0.632, signifies that households with higher income have greater capacity to pay and higher probability of choosing modern cooking fuels. As household income rises, the sources of energy used by the household would be cleaner and more efficient. High income households have access to better domestic cooking appliances due to their higher purchasing power as compared to low income households. This implies the more income of the household means the more conventional end-use energy consumption.

Household fuel expenditure has a significant and positive effect on both consumption patterns of biomass and conventional end-use domestic energy. However, results from the analysis show that it is apparent that fuel expenditure has strong positive correlation with the consumption of end-use biomass fuels compared to the use of conventional fuels (0.765 vs 0.372). Overall, there seems to be an evidence to indicate that there is a clear trend of decreasing end-use conventional energy consumption as household expenditure on fuels rises.

The amount of conventional energy consumed is positively and strongly correlated with the number of modern cooking stoves used. The data in Table 7.1., reveals that adoption of improved stoves increases the likelihood of using more conventional end-use energy. A correlation coefficient of 0.719 implies that the better the efficiency in the utilization of energy resources, the higher is the consumption of conventional end-use energy. This signifies the fact that the provision and adoption of modern energy technologies (such as *Lakech* and *Mirt*) among households has been a great success to increase end-use energy consumption. While the coefficient value for number of traditional cooking stoves is insignificant with the consumption of end use biomass energy. This entails that the number of traditional stoves do not affect monthly biomass end-use fuel consumption but it has significant negative impact on conventional end-use energy consumption (-0.676) at the 0.01 level.

The result of simple correlation analysis shows positive and significant relationship between owning electric meters and the consumption of end-use energy. Its association with end-use conventional energy consumption shows higher correlation coefficient (0.483) compared to end-use biomass energy. This implies that the use of cleaner cooking fuels in the urban areas was associated with having own electric meter. Sample households benefit more from owning electric meters compared to households who obtain electricity by connection.

Households having non-cooking electrical appliances such as refrigerator had higher conventional fuel adoption probability than those without non-cooking electrical appliances. This suggests that households with more number of electrical appliances were found to be more likely to consume electricity which has positive influence on the likelihood of consuming more end-use conventional energy. Households' tendencies to use electricity as a basic fuel could be indicative of improvement in their socio-economic status which enabled them to climb up the energy ladder.

House ownership, quality of housing unit and kitchen type considered to be determinant factors that significantly affect the use of household's end-use conventional energy for household purposes. Households residing in their own housing units tend to use more electricity than those who live in rented houses. Households in owner-occupied housing units are less affected by constraints of electricity compared to those who live in rented houses; this is attributed to the fact that owner occupiers are more likely to install energy-efficient appliances.

Education of the household head was a significant determinant as far as the decision to consume end-use energy is concerned. The level of education determines the preference of a household for cleaner fuel. It was found that education level of the household head has significant positive impact on conventional end-use energy consumption (0.571).

Higher levels of education were associated with a greater probability of the household using modern fuels and a lower probability of using biomass fuels. As the number of years a household spent informal education increases, there is more tendency to consume conventional end-use energy. In other words, the higher the educational level, the larger the probability of using clean fuel sources and the smaller the chance of using wood fuels such as firewood and charcoal. Respondents with higher education would have greater awareness about the health effects of biomass fuels. Education may also help to understand the negative effects of biomass fuels on health.

The result of simple correlation shows significant positive relationship (0.515) between occupation of the head and the amount of end-use conventional energy consumption whereas it shows weak positive association with a household's consumption of biomass fuels (0.134). Households whose heads have higher level of occupation in terms of payment are more likely to spend more on conventional fuels and consume more end-use conventional energy.

Table 7.1 Association of End-use Energy Consumption with the Independent Variables

Pearson correlation	End-use biomass energy consumption (MJ)	Sig.(2-tailed)	End-use conventional energy consumption (MJ)	Sig. (2-tailed)
Fuel expenditure	.765**	.000	.372**	.000
Household income	.100*	.010	.632**	.000
Age of the head	.170**	.000	-.015	.701
Sex of the head	-.040	.309	.013	.743
Family size	.016	.687	-.117**	.003
Marital status	.022	.566	.022	.567
Education of the head	.072	.065	.571**	.000
Occupation of the head	.134**	.001	.515**	.000
Owning electric meter	.211**	.000	.483**	.000
Modern cooking stoves	.052	.180	.719**	.000
Traditional cooking stoves	-.034	.391	-.676**	.000
Other electrical appliances	.111**	.004	.453**	.000
Ownership of dwelling	.112**	.004	.458**	.000
Housing quality	.055	.157	.538**	.000
Kitchen quality	-.093*	.017	.638**	.000

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

Source: Field survey, 2014

The negative relationship between the consumption of end-use conventional energy and household size (-0.117) can be explained as the larger the household size, the less the consumption of conventional fuels. Smaller household size implies greater tendencies to use modern fuels for cooking other than wood fuels. This implies that smaller households generally consume more end-use conventional energy per household member than larger households whereas large family size has less opportunity or possibility to use modern energy sources and to buy different energy appliances than small family.

Age of the household head is also found to have positive influence on the consumption of end-use biomass energy (0.170).The positive relationship between the consumption of end-use biomass energy and age can be explained as the older household head is, the more the consumption of biomass fuels. It was also observed that households with younger heads were less likely to consume end-use biomass energy than the older heads.

7.3. Factors Affecting Overall End-use Energy Consumption

Binomial or binary logistic regression is intended for the modeling of dichotomous categorical outcomes. It can only be used to predict discrete functions and cannot predict continuous outcomes (Ahman, M., and Chakrobartty, S. 2004). Unlike logistic regression, linear regression is used in this study to assess the association between independent variables and a continuous dependent variable (consumption of end-use household energy).

Multiple correlation coefficient (R) and coefficient of determination (R-square) were computed to know how much proportion of variance of the dependent variable is explained by the regression model. The coefficients explain the overall degree of the fit for a regression model and determine how certain one can be in making predictions from the model. In the model summary, multiple correlation coefficient (R)turned out to be 0.891 which shows a good level of prediction and indicates that there is a very high statistical association between the exogenous variables chosen in the model and the endogenous variable (end-use household energy consumption in terms of heat value)

The coefficient of determination value is 0.794, which indicates that the model explained 7 9.4 percent of the variance in the end-use household energy consumption. The remaining 20.6 percent of the total variation in consumption of end-use household energy is unaccounted for by the regression line. This confirmed that the model is well fitted and variables are appropriate (support your argument with a literature). The adjusted R square of 79 percent also confirmed that the model is well fitted and independent variables are appropriate to explain dependent variable (see Annex 10).

When interpreting multiple regression output, it is important to examine the significance test for the relationship and the ANOVA (Analysis of variance) test of the regression model (Peng, C., Lee, K., and Ingersoll, G. 2002). Analysis of variance is appropriate as the study is concerned with differences between scores. It is helpful to assess the overall significance of the model and check how well the model fits the data. F-ratio, which is computed from the mean squared terms in the ANOVA table, is used to test whether or not there is significance relationship between the end-use energy consumption and all other independent variables. The overall significance test of the model, F-test, is computed to be 165.39 which is statistically significant indicating that the given predictor variables in the model are collectively important and explain the consumption of end-use energy in the study area (F statistics is less than 0.05 percent), which imply that the variation explained by the model is not due to chance.

This means that the null hypothesis of no significant effect of the exogenous variables on the amount of end use energy consumption is rejected, and the alternative hypothesis of the model, that the exogenous variables influence the variations in the quantity of end use energy consumed significantly, is upheld. The model is acceptable and is significant to explain end use energy consumption. The statistics confirm that there is a relationship between the dependent variable and the set of independent variables and that the independent variables significantly predict the dependent variable (see Annex 11).

After checking for the model fit and the evaluation of the F-value and R-square, it is important to evaluate the regression beta coefficient which gives results of the regression analysis. Linear regression model is estimated to identify factors explaining household's end use energy consumption. The multiple linear regression equation is stated as:

$$Y= a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots \beta_{15} X_{15} + e$$

Y is the value of overall (biomass and Conventional) end-use energy consumption (MJ); a refers to the constant or intercept point; β_1 through β_{15} refer to the slopes (Beta coefficients) for independent variables. Beta (β) is regression coefficient that indicates the rate of change in independent variable when independent variable is changed by one unit. X_1 through X_{15} are independent variables that are explaining the variance in end use energy consumption and e is an error term. In the model, there is obviously one continuous dependent variable (end-use household energy consumption in terms of heat value) and a number of continuous and dichotomous independent variables which were standardized to allow a better comparison of regression weights. If regression coefficient were unstandardized, we could not compare the effect of the various coefficients because the independent variables are measured on different scales. When we make them standardized, the beta ignores the independent variable's scale of units, and measures in units of standard deviation to have common units. They are then directly comparable to one another to determine the rank order of influence among the variables on the criterion. It is possible to quantify the relative contribution of each predictor to the overall prediction of the dependent variable using beta weight. Thus, the higher the beta value, the greater the impact of the predictor variable on the criterion variable. The beta weights for the independent variables are presented in Table 7.2.

Results from the analysis show that the variables show positive estimated beta coefficients and the existence of significant association with the consumption of end-use energy while sex of the head and number of traditional cooking stoves turned out to be negative. The variables such as fuel expenditure, kitchen quality, number of modern cooking appliances, quality of housing units and household income respectively are the most important explanatory factors causing variation in end-use energy consumption across households. The explanatory variables that lacked significant correlation are family size, age and occupation level of the head. The relationship is statistically insignificant which implies that the variables did not affect the monthly consumption of end-use energy.

Income of the household has a significant and positive effect on the amount of overall end-use energy consumption. This could be because higher income creates more demand for multiple energy sources and enables households to purchase different energy appliances. The degree of association indicates that in urban areas where all energy sources are commercialized, access to energy is determined by the purchasing power of the families. Thus, households with better income level could have better access to all sorts of energy available in the market. In other words, households with more income have better ability to use modern energy and purchase different energy appliances than those with less income.

Increasing income of the household is an indicator of more consumption of energy and hence more expenditure on energy. As the income of the household increases, there is a tendency of spending more revenue on energy and a shift towards making use of a mixture of more fuels. This can be attributed to households' ability to spend more money to buy more types of fuels and different energy appliances for domestic activities. The amount of end-use energy consumption varies in accordance with variation in the amount of fuel expenditure. The result of multiple correlation analysis shows significant positive relationship between the amount of end-use energy consumption and fuel expenditure level. The beta coefficient of 0.288 recorded for fuel expenditure implies that for every unit change in monthly fuel expenditure of the household, the monthly end-use energy consumption would increase by 0.288 units.

The positive coefficient of total energy expenditure indicates that households who spend more on energy are more likely to consume end-use energy than those who spend less on energy. That means, higher energy expenditure by households implies that these households have opportunities to buy more types and amounts of energy especially biomass energy than the modern ones and use different energy appliances. One can infer from the result that the probability of expending on total fuels increases with increase in level of end-use of consumption. The more the expenditure on fuels, the better is the total amount of end-use energy consumption.

A relatively better significant relationship was also observed with kitchen quality ($\beta = 0.213$) and housing quality ($\beta = 0.129$). As housing and kitchen quality increases, the end use consumption increases, thus motivating the household to use fuel saving technology. The correlation between residing in better quality houses and use of end use energy consumption is in support of the assumption that better housing unit is an indicator of wealth or the availability of money to support purchases of the better fuels and related appliances. One can infer from the result that residential quality is one of the prerequisites for consuming more end-use conventional energy. Households living in better housing units are able to use the readily available utilities. Moreover, the data implies that the association between quality of kitchen and use of conventional fuel is significant. Access to a separate kitchen is a significant factor in the adoption of modern fuels.

End-use fuel consumption is also obviously affected by the efficiency of the end-use equipment. What matters is not only the type of fuel used but also the appliances employed. The efficiency level of energy utilization is determined by the quality of appliances a household used. A significant coefficient ($\beta = 0.180$) is observed with respect to owning and using modern cooking stoves. This asserts that for every unit of modern cooking stove increased, the people will increase their consumption of end-use energy by 0.18 units. This implies that the more quality end-use equipment a household possesses, the more the consumption of end-use energy. Even though the number of modern domestic appliances owned by a household has positive significant correlation with the overall end-use domestic energy consumption, the coefficient is not strong enough implying that it is becoming increasingly difficult to obtain affordable appropriate end-use energy technologies, which contribute for proper utilization of the available resources. The negative sign for the traditional end-use equipment (-0.100) reveals that for every unit of this equipment, there is a decrease of only 0.1 unit in the amount of end-use energy consumption. The higher the number of modern cooking equipment over the number of traditional cooking equipment signifies the more the amount of end-use energy consumption.

Table 7.2. Beta weights for Independent Variables

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-259.165	65.686		-3.946	.000
Fuel expenditure	1.274	.100	.288	12.713	.000
Household income	.031	.009	.105	3.498	.001
Age of the head	1.548	.829	.038	1.867	.062
Sex of the head	-56.655	19.625	-.088	-2.887	.004
Family -size	-5.182	4.485	-.026	-1.155	.248
Marital status	19.889	6.471	.093	3.074	.002
Education of the head	16.273	4.465	.094	3.644	.000
Ownership of dwelling	29.796	8.471	.077	3.518	.000
Occupation of the head	2.365	4.197	.014	.564	.573
Owning electric meter	68.830	19.978	.076	3.445	.001
Modern cooking stoves	61.996	12.238	.180	5.066	.000
Traditional cooking stoves	-39.119	13.951	-.100	-2.804	.005
Other electric appliances	19.027	5.994	.066	3.174	.002
Housing quality	55.563	10.034	.129	5.537	.000
Kitchen quality	97.674	11.117	.213	8.786	.000

The fact that education of the household head positively associated with the end-use consumption of energy implies that it is more likely a household to consume more end-use energy at the higher level of education. One can infer from the result that the number of years of formal education of household head is one of the prerequisites to consume conventional fuels. Household heads with higher level of education are more receptive to adopting energy efficient devices.

The beta coefficient of owning electric meter is positive (0.076) implying that households owning electric meters have less weighted energy deprivation counts and consume more end-use energy. It means that if households own electric meter, keeping other variables constant, household's end-use energy consumption increases by 0.08 units.

The positive coefficient of owning electric meter indicates that households with own electric meter are more likely to use end-use energy than households without their own electric meter. The positive coefficient of owning electric meter shows easy access to electricity anytime, permitting the households to use more electric power and energy appliances. Owning of electric meter individually has been given consideration as an indicator of smooth electric utilization. Therefore, sample households benefit more from owning electricity compared to households who obtain electricity by connection. This is probably because households with own electric meters can access electricity easily any time they want and enable them to use more electric power and energy appliances like stove, refrigerator, TV, etc.

The amount of domestic end-use energy consumed correlates with the type and efficiency of domestic electrical appliances a family uses. Using electric appliances for other than cooking is one of the factors that determine positively the end-use household energy consumption. Electrical appliance ownership was positively correlated with electricity use, and metered electricity customers used more appliances than those with extension cords. The coefficient of owning non-cooking electrical equipment is positive, it shows that households having refrigerator, television and radio sets are more likely to consume high end-use energy than households with less and without non-cooking electrical equipment.

The positive relationship with marital status shows that married heads used higher end-use energy than those who divorced, widowed or separated. An interesting contrast is observed in the energy use pattern between MHHs and FHHs. A negative but significant coefficient is observed with respect to sex of the household head and end-use energy consumption. There seems to be some evidence to indicate that the probability of using over all end-use energy consumption is higher for FHHs than the MHHs. Even if the MHHs are in a better economic status, female heads are economically empowered and are often found in a better economic status than the FHHs to make a decisions power. The probability of owning better baking and cooking stoves is getting higher for FHHs. FHHs could be better in utilizing fuel saving technology as they have adopted improved biomass stoves far more quickly than MHHs. FHHs are more likely to adopt the *Mirt* biomass cook stove and *Lakech* charcoal stoves.

CHAPTER EIGHT

8. HOUSEHOLDS' CHALLENGES AND COPING STRATEGIES WITH CURRENT USE OF ENERGY

8.1. Households' Challenges with Current use of Fuel

This chapter seeks to identify, understand and analyze households' energy problems and the strategies used by urban households to address their energy problems. In the first section of this chapter, the challenges to the use of household fuels have been identified. The next section concerned with households' households' actions to address the energy insecurity challenges that confront them.

8.1.1 Energy Insecurity and Affordability Problems

Energy is the power upon which all our activities depend and it is an indispensable fundamental resource for human survival, economic development and social growth (UNFCC 2002). It is obvious that urban households are intensive consumers of conventional types of energy compared to rural households. However, most urban households are still inadequately served by modern energy provision and continue relying on biomass fuels mainly for basic baking and cooking activities.

In rural Ethiopia, a fuel crisis means dark nights and walking tens of kilometers to fetch for firewood. In urban Ethiopia, it is common to see lines of vehicles, and women and children at fuel stations. Disruption of life and economic activities because of price escalation is also a manifestation of the fuel crisis (UNDP 2009). This is true especially for the low income households who have no alternatives other than meeting their fuel demands with inefficient and more polluting sources. Thus, meeting the energy requirements in sustainable manner continues to be a major challenge and the livelihoods of urban and peri-urban households will continue to be significantly impaired by energy crisis thereby hindering any improvements in their way of life.

When respondents were asked to reason out why a problem in energy use in the household, the majority of sample households (60.5 %) reported that there is no enough money to pay for the energy they need. These people cited the rising cost as the main reason for non-adoption of conventional fuels and improved baking and cooking stoves. The prices of conventional fuels are still rising and the high up-front costs for improved appliances prevent the majority of households from changing their consumption patterns. More than half of sample households (52.43%) have the feeling that biomass fuels are scarce. The proportion of fuel wood and charcoal consumers who reported shortage were 52.23 percent and 52.47 percent of the total, respectively.

Less than half of electric using households (46.5%) perceived irregular supply of electricity as the main problem and almost less than a third of those who responded (32.98%) have the opinions that there is shortage of kerosene. Whilst a minority (17%) mentioned that unavailability of LPG as the major problem associated with energy usage in their community. They replied that physical access to energy is hampered by frequent shortages of LPG. Households' perceptions for problems of energy insecurity indicated in Figure 8.1.

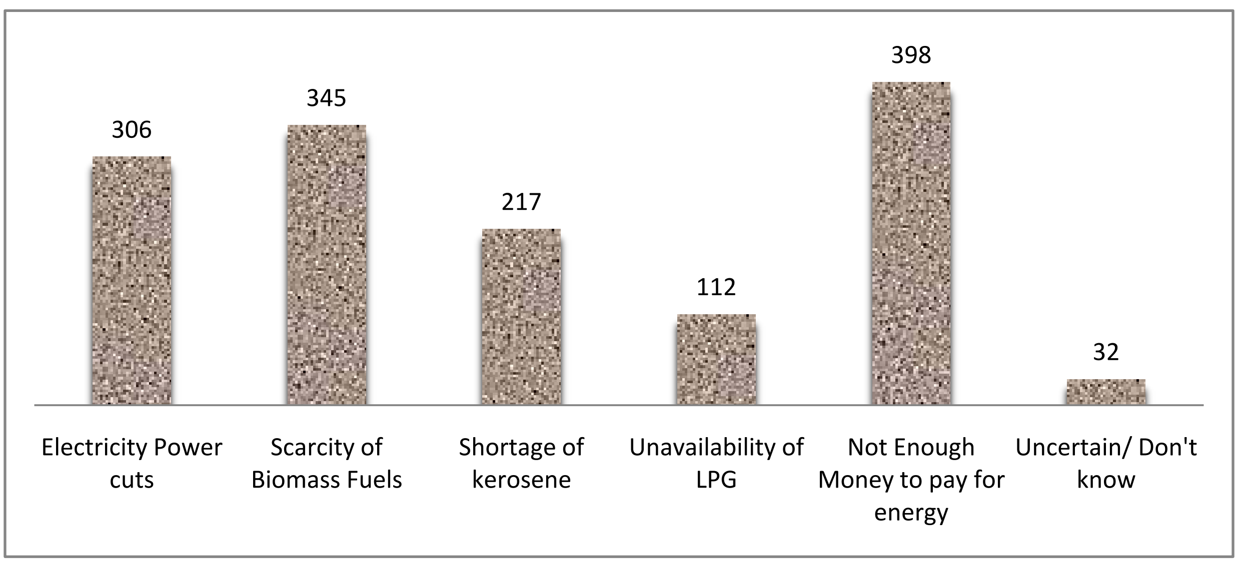


Figure 8.1. Number of Households Perceived for Problems of Energy Insecurity

Source: Field survey, 2014

All households in the survey were asked their opinions about the ease of access to an electricity connection. The majority of respondents perceived electricity as fairly available. When urban households get connected to electricity they use it mainly for lighting and TV viewing and radio listening rather than cooking. It can be seen from the data in Figure 8.2., that the majority of households (78.6 %) complained about frequent and unexpected power interruption. Sudden power cuts and interruptions which make electricity a very unreliable source of energy as the users find it hard to predict its availability. Such erratic supply of electricity according to the interviewees affects their social as well as economic life. Most households are unable to be flexible in the allocation of time for their household and economic activities due to such power disruptions. Some even complained of having their appliances damaged due to the frequent unannounced power outages.

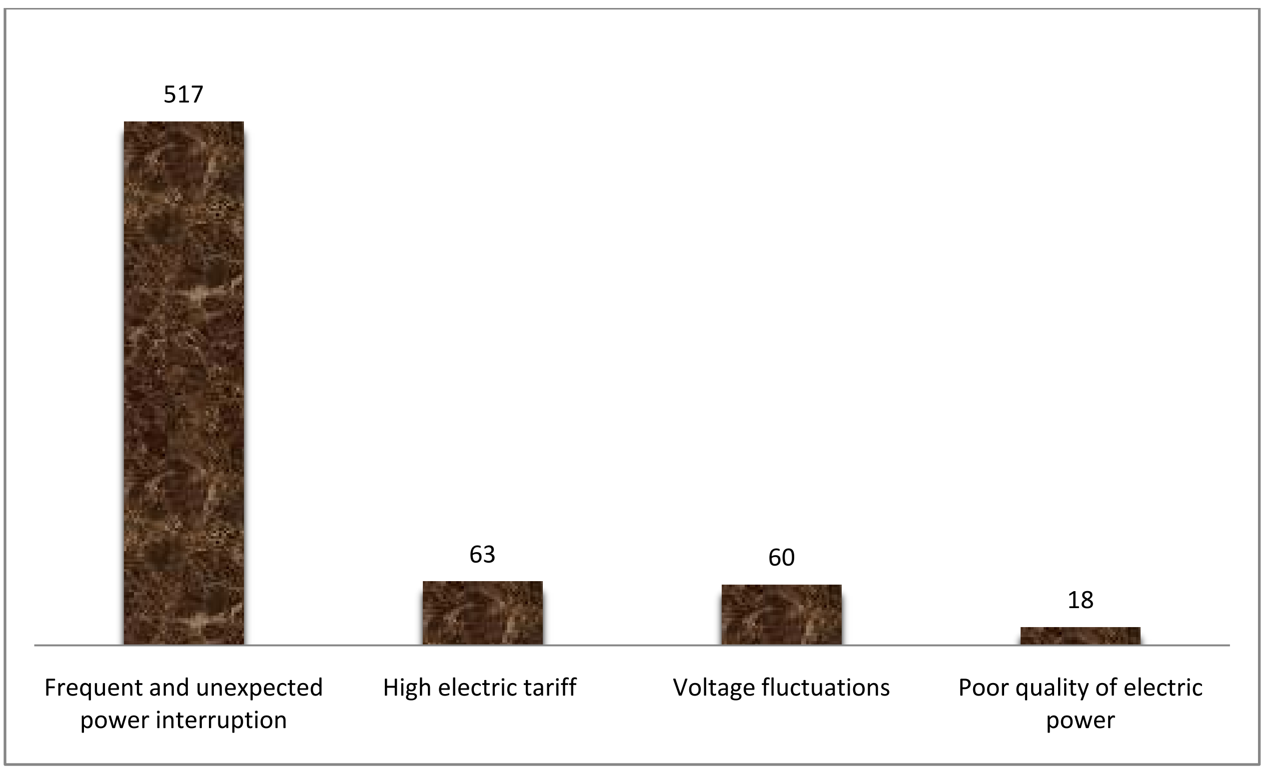


Figure 8.2. Number of Households Perceived for Electricity Supply Problems

Source: Field survey, 2014

Other problems in the supply of electricity are high electric tariff (9.6 %) and voltage fluctuations (9.1%) as well as poor quality of electric power (2.8%). The outcomes of the focus group discussions also identified inefficiencies and mismanagement by the electricity providers. Interview with representative of Ethiopian Electricity Utility (EEU), Arba-Minch branch admitted that there is a major power shortage which happens for various reasons like overloading of electricity network, damage to electric transmission lines and substations. He said the power consumption trend in the country is changing. The problem is that there is a high power demand that the transformers at times are unable to accommodate. Such high power demand is beyond the capacities of transformers. The problems, according to the energy providers, emanate from inadequate infrastructure, lack of finance and capacities of personnel.

Focus group discussions revealed that the problem of energy insecurity is not only related to electricity but it also applies to kerosene. As already stated 32.98 percent of sample households asserted that they have always problems with kerosene supply. Kerosene makes food preparation faster but the shortage associated with it makes it unreliable. When kerosene shortages occur, sometimes it takes a month to get back into the market.

Though biomass fuels meet the largest share of the total domestic energy requirements, they account low proportion of end-use energy consumption in terms of heat value. Most people often have a limited choice of technologies that convert energy to useful services. The end-use technologies used by most households in the town are inefficient that result in deforestation. The proportion of households reported fuel shortages by source of energy are presented in Table 8.1.

Table 8.1 Number of Sample Households Reported Fuel Shortages by Source of Energy

Energy End-uses	Fuel Type	Households Reported shortage	Households Reported no shortage	Total Number of Responses
Baking/Cooking	Fuel wood	259	237	496
	Charcoal	297	269	566
	Sawdust	31	2	33
	Dung cake	68	28	96
	Electricity	89	102	191
	Kerosene	54	111	165
	Biogas	4	13	17
Lighting	Electricity	205	438	643
	Biogas	4	13	17
	Candle	38	458	496
	Dry cell	21	28	49

Source: Field survey, 2014

A limited number of peri-urban households are able to install the biogas plants, while majority are out of reach for such plant and unable to access it. Only few households have used such quality fuel for cooking, while the majority households continue to rely on low quality biomass fuel such as fire wood, charcoal and dung. According to one informant, “*There are biogas plants in this village but it is no use for us as we cannot have it because biogas plant installation is not targeting the majority"*. The implication here is that this situation has created more inequalities within such a small community and may worsen the health and environmental degradation problems as households tend to consume more biomass fuels.

Discussion with biogas using peri-urban households and direct observation of the biogas plants revealed impacts were not generally positive. Biogas plants require the collection of dung and water which is an additional burden on women. Key informants noted that a biogas consuming household must have a minimum of four heads of cattle to secure sufficient dung availability (20kg of dung) for the smallest biogas plant ($4m^3$). Nonetheless, the visible challenges of the biogas technology could be noticed during the study. Most users in the study area do not have a steady inflow of useful inputs (animal dung). According to informants the biogas plants need frequent repairs. Getting skilled personnel and accessories has long been a problem at the villages.

8.1.2. Biomass Related Health and Environmental Problems

In the study area households use energy sources mainly for baking, cooking and lighting purposes. Disparities in cooking practices were not reflected across the different socioeconomic groups. Baking *Injera* and cooking local foods are the two most important activities accounting for the bulk of urban domestic wood fuels consumption in the study area. Baking and cooking energy consumption patterns are characterized by a high dependence on wood fuels which remain to be the dominant source of energy for all income groups despite the fact that almost all urban and peri-urban households have access to grid electricity.

The sample households were asked for their view concerning the impact of biomass combustion. The consumption of biomass fuels reveals that women are at a disadvantage to men as far as negative health and safety impacts of these fuels are concerned. The longer hours of exposure to smoke and particulates in smoky kitchens experienced by women compared to men is considered to be a contributing factor for women to suffer more health problems than men. Women took the major responsibility for managing the firewood for cooking and they were much concerned about the smokes caused by biomass burning that affected their health in different ways.

Among the households that reported use of biomass fuels for baking and cooking, the majority (91%) were using traditional open fire baking stove which emits very high levels of smoke. This is the main risk factor contributing to the health problems of householders due to exposure to indoor air pollution. The health impact of biomass fuel use is well understood by almost all biomass users. According to the responses, over three quarter (75.8%) of the women was kept to stay indoors, even though they know the impact. They usually care for the daily need and provide less concern on the subject of fuel and stove type they used.

Respondents expressed the health effects while cooking with biomass solid fuels. For example, one interviewee put it: *I used to bake and cook with wood fuels even though I feel eye irritation and headache so often.* As can be seen from Figure 8.3, there are a total of 120 women victims of health problems due to continuous burning of biomass fuels. The most commonly cited health effects related to biomass cooking are eye and breathing problems. Among the total victims, the findings show 47.5 percent of the women respondents in urban and peri-urban households suffer from eyesight problems. Almost a third of those who responded (32.5%) indicated that they had breathing problems. Just a quarter (25.83%) felt they had back strain problems. Residents in peri-urban area were more inclined to perceive high health problems compared to residents in the town as they are significantly dependent on biomass fuels for baking and cooking.

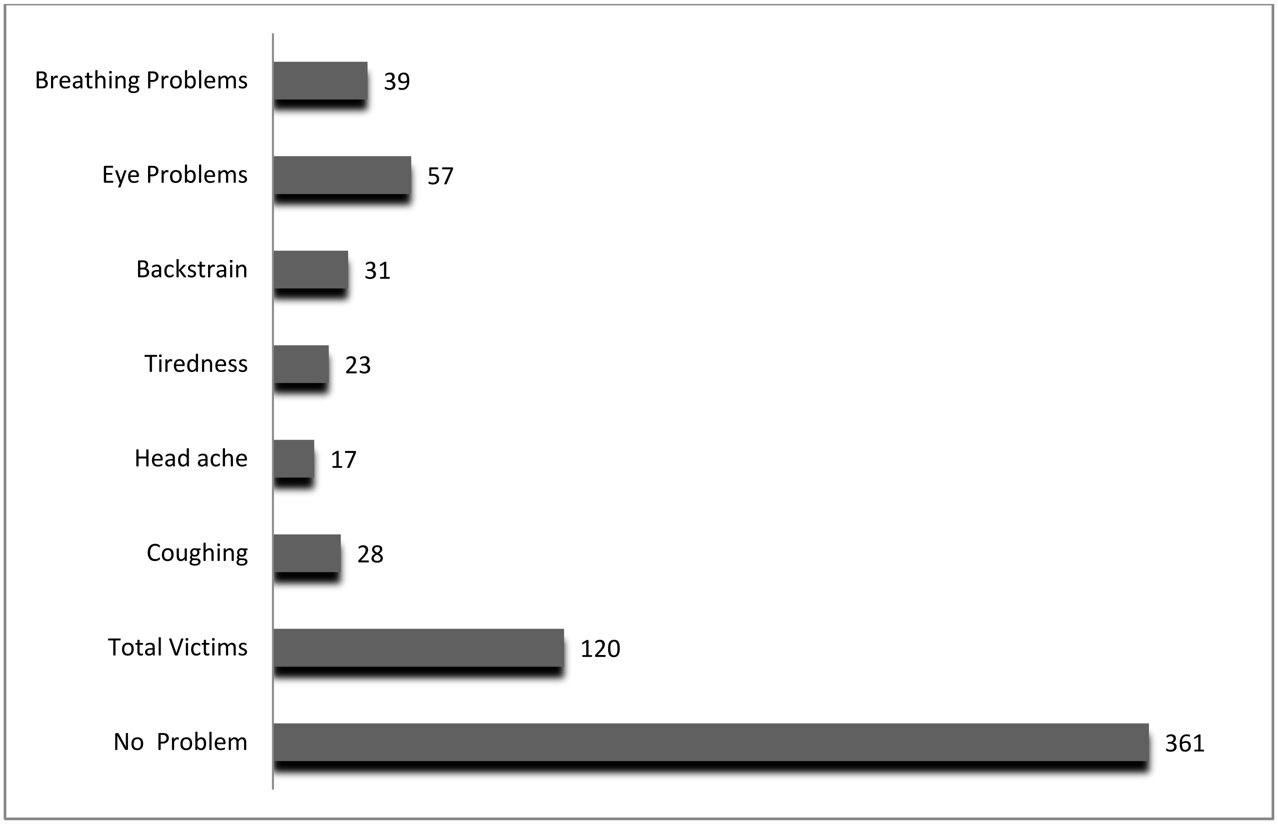


Figure 8.3. Number of Women Perceived Health Problem

Source: Field survey, 2014

Further analysis showed that the high dependence of urban dwellers on biomass resources has also contributed to the current environmental problems. However, still many families often do not understand the environmental impact of biomass fuel use. The major environmental problems associated with current household biomass production and combustion is presented in Figure 8.4**.** Only very few households (4.98%) reported no environmental problem. The findings also reveal that 22.12 percent of the respondents felt that there is high scarcity of biomass fuels. An increase in household energy demand has led to massive deforestation on the outskirts of the town. The increase in wood fuels use has been linked to a significant increase in deforestation in the surrounding peri-urban area.

This has created heavy shortages of fuel wood resources thereby leading to energy crisis. About 21.47 percent of those who were interviewed indicated that there is intense loss of forests. Households that are heavily dependent on forests are an important source of forest degradation and tend to be quite vulnerable to the effects of forest decline. Native forests have been depleted as a result of increasing demand for fire wood and charcoal making. Over the years, this area has experienced intense deforestation due to the activities of wood fuel poachers in the town. Whilst others mentioned that they had felt as there are high temperature (16.12%), continuous loss of soil (13.92%) and lack of rain (13.19%). In summary, the increasing demand for wood fuels is contributing to widespread deforestation of natural woodlands. Both wood and charcoal are produced and traded by the informal sector actors. This is contributing to unnecessary high level of biomass resource extraction and consumption which leads to continuous cutting off trees.

Overexploitation of forests has already led to increased degradation of the land which has been linked to a number of adverse environmental effects. When respondents were asked to identify which group of the community is more affected by environmental impact of biomass fuel use, the majority (38.5%) felt that urban and peri-urban low income households particularly of women are at high risk. The scarcity of the biomass energy, on one hand, and the continuous increasing fuel prices, on the other, imply that timely and continuing interventions are required to halt the household energy problem.

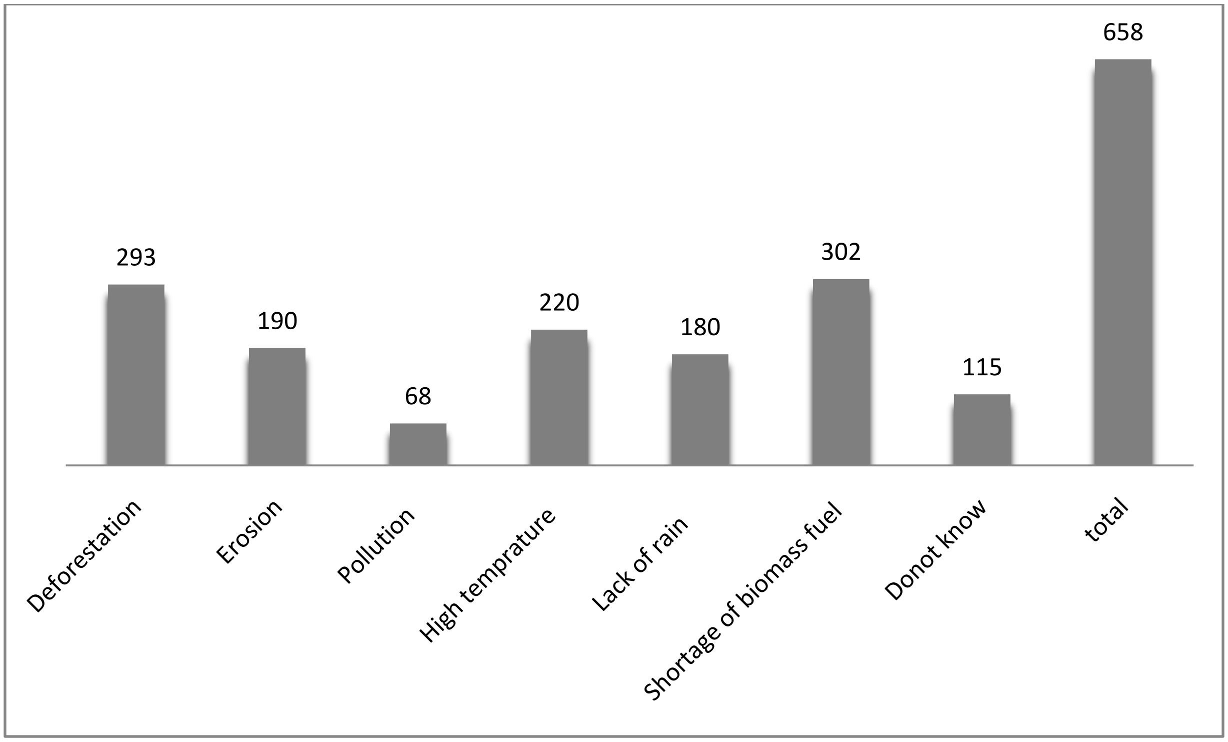


Figure 8.4. Number of Survey Households Perceived Environmental Problem

Source: Field survey, 2014

8.2. Households' Strategies to Combat Energy Related Problems

It is important to consider households' actions to address the energy insecurity challenges that confront them. Households pursue a number of strategies to cope with problems that affect energy security. One of the most appropriate strategies to provide a sustainable energy source for the urban and peri-urban households is to give a considerable focus to alternative sources of energy that can alleviate the energy problem.

Survey results reveal that households employed different coping mechanisms to handle increasing scarcity of fuels. About 43 percent of the respondents tried to manage the problem by using alternatives. Households have responded to fuel wood shortages by purchase other biomass fuels; they shorten cooking times and cook fewer meals. Charcoal is most important substitute of fuel wood as reported by 65.46 percent of the total fuel wood consumers. When fuel wood is scarce, peri-urban households cope by substituting fuel wood with dung cake (14.89%). The growing shortage of fuel wood for household consumption in these areas has led to the dung produced burnt as principal cooking fuel. However, biogas and kerosene play slight role as fuel wood substitute. While the results suggested in most cases fuel wood and sawdust might be complement. A possible explanation for this is that, when the two fuel types were used together, they burned longer.

Charcoal is used mainly for cooking function and in period of its shortage, fuel wood (49.77%) and kerosene (27.44%) were common substitutes. The alternatives wood fuels still remain viable solutions for low income peri-urban households with a significant health risk as a result of indoor pollution. Moreover, in peri-urban residential area, among higher income households biogas is most common renewable energy technology that can practically substitute for burning of fuel wood and charcoal for cooking in peri-urban area.

Kerosene appears to be consumed by a relatively small segment of the peri-urban population. The result of the study showed that kerosene is relatively expensive; therefore its use is limited. During the time of kerosene shortage, the most common substitutes are charcoal (51.90%) and fuel wood (32.90%). The interviewees pointed out that they decided to use both charcoal and wood because sometimes they find it difficult to get kerosene to buy. Thus they would shift to charcoal as soon as kerosene becomes unavailable or they would use both at the same time in order to maintain constant supply of energy in the house. Most households forced to shift to charcoal whose supply is relatively regular.

When many of the sample households face electric power interruption, residents use alternative energy sources such as fuel wood, charcoal and kerosene for baking and cooking. The use of electricity as domestic fuel other than for lighting is limited due to low income levels of the majority of the households. When urban households get connected to electricity they generally continue to use biomass fuels for cooking and the use of electricity was mainly for lighting and TV viewing and radio listening rather than cooking. Many people with access to grid electricity are still relying on biomass for baking and cooking end-uses.

Table 8.2. Number of Sample Households Using Alternative Baking and Cooking Fuels

Primary Fuel	Alternative Fuel at the time of shortage							Number of users reported shortage
	Fuel wood	Charcoal	Sawdust	Dung cake	Electricity	Kerosene	Biogas	
Fuel wood	-	170	7	39	11	18	14	259
Charcoal	149	-	-	24	29	82	13	297
Sawdust	26	3	-	2	-	-	-	31
Dung cake	46	12	4	-	-	-	6	68
Electricity	35	39	-	-	-	11	4	89
kerosene	18	28	-	-	8	-	-	54
Biogas	2	2	-	-	-	-	-	4

Source: Field survey, 2014

As a coping mechanism from the sample households who still utilize electricity, 37.7 percent of electric users tried to cope up by minimizing consumption, 27.5 percent shifted to other fuels while 34.8 percent utilize both ways. In period of electricity shortage for baking purpose, more than a third of these electricity users (39.60%) utilize fuel wood as alternative baking fuel. Charcoal and kerosene are also used as major electricity substitutes for the purpose of other cooking as reported by 43.56 percent and 12.87 percent households of electricity consumers, respectively. The results indicate that for a small proportion of sample households (26.90%) electricity is found to be a substitute not only to the wood fuels, but also to the modern fuel, kerosene while for the majority (73.10%) electricity is not found to be a substitute to the wood fuels with respect to baking and cooking. Most urban households cannot easily make a transition from biomass to electricity for cooking end-use since the high costs of modern cooking stoves are major constraints for them. The government and other NGOs should facilitate in availing environmentally sound energy sources at affordable price using innovative practices.

CHAPTER NINE

9. CONCLUSION AND RECOMMENDATIONS

9.1. Conclusion

The study was set out to explore the linkages between energy consumption, gender disparity and income poverty among the urban and peri urban households of Arba-Minch town, Southwestern Ethiopia. The study sought to answer how household end-use energy consumption is related to the socio-economic and demographic characteristics of households at the local level and describes the current gross and end-use energy consumption pattern among households residing in the town and its surroundings.

The study reveals that despite the fact that a majority of sample households used electricity at home, wood fuels (wood and charcoal) remain to be dominant sources of energy for baking and cooking purposes. Charcoal is most preferred urban cooking fuel and is still very important in the energy mix of all households. The results show that majority of the households regardless of their economic status combine the use of charcoal with other source of energy in their household. It is also the most important substitute of fuel wood as reported by 65.46 percent of the total fuel wood consumers. The main reason for preferring this energy source is affordability of the fuel and the related stoves. The importance of the study and its findings may help to address the problem through, mainly by, creating public awareness about the effect of biomass fuel use on the surrounding environment. In this paper, the levels of energy consumed by households need to be analyzed in order to make inferences regarding the level of wellbeing of a household.

The findings revealed that real access to energy services can be limited by the purchasing power of the household, the cost of energy and cost of energy using equipment. The ability to use any modern fuel is dependent on the energy-users' ability to afford not only the fuel on a regular basis but also their ability to pay for the energy-using appliances. In spite of the significant household electrification program in the last few years, most urban and peri-urban households in the study area still appear not to be benefiting significantly from the availability of electricity.

Most urban and peri-urban households cannot easily make a transition from biomass to electricity for cooking end-use since the high costs are major constraints for them. Evidence points to the simultaneous use of different fuel regardless of income levels. Households continue to use different fuels (a mix of fuels) for baking and cooking irrespective of income and they do not immediately abandon the use of fuel wood. It is unusual for families to make a complete fuel switch from one fuel to another as their income increase.

The majority of households achieve fuel transition as far as lighting is concerned. However,the majority of electricity users (78.6 %) (Both metered and extension cord) complained about frequent and unexpected power interruption which make electricity a very unreliable source of energy as the users find it hard to predict its availability. Such erratic supply of electricity according to the interviewees affects their social as well as economic life. In period of electricity shortage for baking purpose, more than a third of these electricity users (39.60%) utilize fuel wood as alternative baking fuel. Charcoal and kerosene are also used as major electricity substitutes for the purpose of cooking as reported by 43.56 percent and 12.87 percent households of electricity consumers, respectively.

LPG is not an alternative urban cooking fuel option due to lack of general availability and much higher cost for household use. LPG gas using appliances are unavailable and their costs are beyond the financial reach of most households. Although there is significant interest in the area, the cylinder is not available at affordable price in the study area. The biggest concern about the use of LPG was initial equipment costs are quite high. Furthermore, use of kerosene is less common as a primary cooking fuel; however, more people use it as a secondary fuel, mainly for fast cooking.

In terms of end-use energy consumed, conventional fuels occupy the leading position (74.63%) while biomass fuels provide low energy heat values (25.37%) due to low efficiency of utilization. In spite of the fact that biomass fuel would remain important household fuel for majority of the households, the share of electricity is the most important conventional source of energy to meet the largest share of the total domestic energy requirement in terms of end-use energy consumption. Among the all energy sources, the proportion of electricity in terms of heat value of end-use energy is the highest (72.48%) followed by charcoal (19.72%) and fuel wood (5.33%). Thus, a majority of households get lesser energy services due to large dependence on wood fuels. It is becoming increasingly difficult for most people to obtain affordable energy technologies that convert energy to useful services.

The study has shown that switching from biomass to conventional fuels for baking and cooking was difficult for more than half of the sample households (52.3%). Fuel switching is partial for 44.8 percent of the households while only a minority (2.9%) switches completely. The study results indicate that there is a tendency to use more wood fuels with limited conventional fuels for the purpose of baking and cooking. This indicates no significant switching from wood fuels to electricity had occurred in households' energy use. An increase in household income does not necessarily mean an overall switching, where biomass cooking fuels totally substitutes for clean cooking energy sources. Middle and higher income households are using energy combinations rather than replacing biomass fuels with conventional ones for baking and cooking purposes. This implies that wood fuels (wood and charcoal) are still the choice of the majority of urban households for baking and cooking and remains to be dominant in all income urban households in spite of the fact that more than half of sample households (52.43%) have the feeling that biomass fuels are scarce.

There is a considerable variation in expenditure patterns on household energy resources by the sample households depending up on a household's economic status. The amount of expenditure made on fuels for domestic purpose is creating more pressure on family budget as the result of increasing scarcity of fuels. The higher price elasticity for fuels affects adversely all consumers but most critically the low-income groups. Low income households account higher proportion of biomass fuels (68.75%) as compared to that of other income groups in terms of expenditure due to their less purchasing power for other alternatives sources of energy, they continue to spend more on biomass fuels. Fuel price increase was a challenge for urban and peri-urban households and there is high strain on household's budget particularly among households of the low economic strata who often end up spending a substantial proportion of their household income on energy when compared to the share spent by high income households.

The cost of energy consumption is getting alarmingly high and too burdensome for the households. Growing prices of modern fuels is the major concern to majority of urban consumers. The prices of fuels are still rising, and this trend is expected to continue in the coming years unless effective action is taken. Urban low income households are the first to feel the rising cost. The percentage of income the low income households spend a significant proportion of their limited income (17.50 %) on energy while the high income households expend 8.45 percent of their budget for the same purpose. The lower income households face higher financial burden to meet their basic energy needs. With their inadequate and irregular income, these households cannot keep up with the high cost of living.

As there is a vicious circle between energy poverty and income poverty, it is important to take into consideration the income level of the households to address energy poverty. It is observed that the problem of energy poverty is acute among the income poor households as people with less income have limited access to clean fuels. This implies that low income families clearly suffer from energy poverty because they do not have the minimum amount of energy for their basic necessities of living. The end-use energy consumption level of energy poor households lowers as they are unable to use modern energy for cooking and they tend to stick to consumption of wood fuels. Most households in income poverty were in energy poverty as they find it difficult to acquire high priced cleaner fuels. Such limited use of clean energy and reliance on traditional biomass deter opportunities for economic and social advancement. Therefore, reducing energy poverty helps to reduce income poverty, meeting the energy requirements in sustainable manner continues to be a major challenge and the livelihoods of urban and peri-urban low income households were significantly impaired by energy poverty which will seriously slow down their wellbeing and hinder their efforts to improve their living conditions. Nevertheless, energy poverty has been also considered as being different from income based poverty. It is common the income poor are more likely to be energy poor; however the energy poor are not all income poor.

Multiple regression analysis revealed that the household income has a significant positive effect on the probability of using clean fuels as a cooking fuel over traditional fuels. End use energy consumption significantly increases with a rise in a family income. This could be because higher income creates more demand for multiple energy sources and enables households to purchase different energy appliances. In other words, households with more income have better ability to use more energy sources and purchase different energy appliances than those with less income.

The present study criticize energy switching hypothesis as it fails appropriately to account for other factors. It was revealed that income alone does not determine adoption and choice of fuel types. Other socioeconomic characteristics were also important in determining household fuel choice. Households in owner-occupied housing units are less affected by constraints of electricity compared to those who live in rented houses; this is attributed to the fact that owner occupiers are more likely to install energy-efficient appliances. Education of the household head was a significant determinant as far as the decision to consume end-use energy is concerned. The fact that education of the household head positively associated with the end use consumption of energy implies that it is more likely a household to consume more end-use energy at the higher level of education. Similarly, households whose heads have higher level of occupation are more likely to spend more on conventional fuels and consume more end-use conventional energy.

The results of the study show that residential quality is one of the prerequisites for consuming more end-use conventional energy. Households living in better housing units are able to use the readily available utilities. Even though the number of modern domestic appliances owned by a household has positive significant correlation with the overall end-use domestic energy consumption, the coefficient is not strong enough implying that it is becoming increasingly difficult to obtain affordable appropriate end-use energy technologies, which contribute for proper utilization of the available resources. Policy makers should think in terms of encouraging fuel substitution by reducing prices of modern fuel sources and adopting pro-poor strategies.

Despite the fact that electricity consumption is likely to reach nearly all the households, the findings of this research provide insights for slow energy transition prospect in household energy use. There seems to be some evidence to indicate that number of urban households are unable to change their energy consumption from using woody biomass to modern energy fuels by installing improved cooking stoves thus, they consume less end-use cooking energy services. This means the consumption of wood fuels for baking and cooking is not declining at all income levels. Wood fuels are still the choice of most households for baking and cooking purposes regardless of household's economic status.

The study results indicate that most urban and peri-urban households are not directly moving up the energy ladder for baking and cooking. Electricity is likely to reach nearly all the households, nevertheless most households do not enjoy the full benefits of electricity. Most urban and peri-urban households cannot easily make a transition from biomass to electricity for baking and cooking end-uses since the high costs are major constraints for them. This implies that wood fuels are still the most important source of energy and remain to be dominant. The majority households often lack the ability to optimize their consumption through improved technologies (such as electrical appliances and gas cylinders).

The heavy dependence together with inefficient utilization of biomass resources for energy have resulted in high depletion of the forest resources which gradually contributed not only to the increasing scarcity of biomass fuels but also the combustion of these fuels can lead to serious health damage. The most commonly cited health effects related to biomass cooking are eye and breathing problems. An increase in household energy demand has led to massive deforestation on the outskirts of the town. This has created heavy shortages of fuel wood resources thereby leading to energy crisis. This may result in serious adverse consequences for health, environment and economic development which hinder households' efforts to improve their living situations. Therefore, for the majority of urban households, meeting the energy requirement in a sustainable manner continues to be a major challenge.

A reasonable approach to tackle this issue could be to review the energy development strategies and search for mechanisms that minimize dependence on biomass fuel. The surrounding forest depletion demands urgent efforts to design an integrated approach for sustainable forest resource management and utilization. The findings of this thesis could be used to help, from the viewpoint of protecting forest cover and reducing the ill effects of biomass fuel use.

This study suggests that increasing end-use efficiency should be given greater emphasis as an important prerequisite and cost effective solution to tackle household level energy problem. It is important to change households cooking practices by employing proper end-use technologies so that the pressure on surrounding forests and soil resources could be alleviated and household energy-related problems tackled.

9.2. Recommendations

On the basis of the findings of the study, the following recommendations are forwarded.

The cooking energy needs of the households cannot be sustainably met because the biomass resource base is subjected to continuous depletion levels. The existing supply of wood fuels could barely cope up with the ever increasing demand for more fuel domestic requirement. Despite the fact that wood fuels would remain important fuels for majority of the households, the local authority did little to protect forests in the outskirt of the town and no efforts were made to increase its supply.

A key policy priority should therefore be to plan for the long-term care of endangered forests. There is a need to develop sustainable energy sources and practicing afforestation and forest management programs to overcome the problem of deforestation of natural forest. The energy policy must support ways to use wood fuels more efficiently and sustainably through encouraging conservation of natural vegetation by growing trees as energy resources must be strengthened and intensified.

The local government should give attention to the amount of depleted natural resources and rate of rapid deforestation to lessen the environmental impact from overexploitation of these resources. To combat loss of natural wood resources, it is important to control and restrict the flow of wood fuels into the town and take immediate actions over the illegal harvesting of forest resources. Urgent action should be taken in this area by designing appropriate patrolling mechanisms and deploying sufficient and strong manpower to secure the forest from radical loss.

It is important to control and restrict the flow of wood fuels into the town and take immediate actions over the illegal harvesting of forest resources. The Government should initiate and design ways of improving the supply of wood fuels in a sustainable manner. Wood fuels producers would be licensed and that local government would be able to develop and enforce sustainable forest practices. Limited numbers of urban-based wood fuel traders must able to obtain exploitation permits. Thus, it would be worthwhile for local institutions to support and facilitate fuel wood markets based on sustainable harvesting and clean combustion technologies (to limit adverse health impacts), to secure these advantages into the future, thereby by contributing towards sustainable rural livelihoods.

The efforts of the local government in promoting fuel-efficient technology and alternative fuels have been inadequate. To mitigate energy related problems policy-makers must understand the links between national policy and the real local level effects on poor people if they are to develop effective evidence-based policy. The energy planning and related policy should be implemented at disaggregated level in line with local realities. Current national and local level programmes clearly need to involve communities in the planning process, to ensure that energy services are appropriate, socially acceptable and sustainable (both economically and environmentally). Considering the energy needs of the whole community when planning energy supply can result in solutions that meet energy demand more efficiently and cost-effectively.

The policy options could be envisaged to redress the urban fuel problem and reduce the pressure of urban centers on peri-urban hinterlands. To tackle household level energy problem, the government should develop policies and regulations that are directly targeted at reducing the upfront cost of access to energy-saving devices hence making it affordable accessible and affordable. Through disseminating fuel-efficient stove with a much higher level of energy efficiency such as the *Mirte,* and electric *mitad* and better energy alternatives, the pressure on forest and soil resources could be alleviated and the demand for more supply of fuels could easily be met. Households largely dependent on biomass fuels should be encouraged to make fuel substitutions that will result in more efficient energy use and less adverse environmental, social and health impacts, a subsidization of modern fuel price should be effective instruments. Innovative financing mechanism and credit arrangements or subsidies should be created and targeted directly to the poor, to make energy equipment affordable and to enable households purchase LPG cylinders and its related accessories.

A price subsidy policy for modern fuel may be one of those policy instruments to reduce the consumption of wood fuels and increase the choice of modern energy sources. The major hindrance for owning fuel saving technology at household level is the economic status of the households. It is recommended that projects related to household energy should be strengthened to develop affordable appliances. Policy priorities should be given to technological alternatives and the government and other stakeholders need to promote interventions that will enable low income earner to use higher-quality and lower-emission fuels.

Households that are heavily dependent on wood fuels tend to be quite vulnerable to the effects of forest decline. They deserve much closer attention from energy policy. In order to encourage more households to make fuel substitutions, there is a need for a policy that targets the poor to compensate for the price increase. Access to credit should be facilitated to low income households in order to own improved stoves to utilize the available modern fuels.

People should aware that modern fuels are cheaper than traditional fuels in terms of useful energy service. Urban household energy transition from biomass fuels to electricity is one response to reduce pressure on rural hinterlands. To ensure reliable sustainable electricity, national electricity utility should give priorities to avoid load shedding or power cuts and keep electricity prices low.

One of the most appropriate strategies to provide a sustainable energy source for the urban and peri-urban households is to give a considerable focus to alternative sources of energy that can alleviate the energy problem. The policy should direct to alternative sources of energy like utilization of solar energy and biogas rather than still giving more emphasis on biomass fuels as a major source of energy for the majority. These alternative fuels help to reduce demand for biomass and increase efficiency of energy use to improve their economic wellbeing and utilization of their time properly for economically productive activities.

The findings revealed a considerable potential for reducing the pressure on local forest resources by substituting or switching from fuel wood to biogas. Awareness within communities will be created and promoted so as to encourage more installations. The participation of people should be ensured for convincing people to adopt biogas technology and encourage local production of biogas installation using local materials for the widespread adoption of the innovation. Dissemination and promotion of bio-gas digesters would be advisable and the private sector should be encouraged to intervene in the field. The government in collaboration with the private sector (NGOs) should participate by designing projects which facilitate the dissemination of the biogas technology. This will help reduce consumption of wood, implying a reduction in the pressure of wood resources and contributing towards mitigating deforestation.

Energy can contribute to widening opportunities and empower people to exercise choices. Without access to efficient and affordable energy sources, people have very limited opportunities for economic and social advancement. Hence, access to energy has to be considered on equal terms with the other basic services, in order to improve the living standards of disadvantaged population groups, enhance economic growth and increase the incomes of the poor. Energy poverty need to be addressed in order to reduce income poverty, therefore, energy policies should be harmonized with poverty reduction objectives. Access to modern fuels eases women's domestic burden and thereby promotes women empowerment through their participation in economic activities. As women are amongst the most vulnerable groups to energy related problems, it is important that special attention be given to them in energy policy. Addressing gender issues in energy can lead to more gender- equitable sustainable livelihoods and will make an important contribution to reducing poverty. Gender issues are therefore to be integrated in other development programmes and women should be the focus of efforts to bring access to modern energy, since bringing energy to women helps lift communities out of poverty.

The study used cross-section data. The cross-section analysis of energy expenditures is useful to give us an idea of how households with different socio-economic characteristics compare. However, this method cannot give any indication of what changes in household circumstances may have an impact on energy consumption. What is now needed is a longitudinal analysis in the foreseeable future study to be able to identify whether changes in the socio-economic circumstances of the household lead to changes in energy consumptions.

Further research should be undertaken to investigate what changes in household circumstances may have an impact on energy consumption. To generate achievable policy strategies and development targets with regards to energy poverty, there is a need for more studies at the local level to allow further assessment of local dimensions of the subject. A further study could assess the long-term and wider range effect of energy poverty at household levels. Such studies could help in the design of better strategies and policy instruments in the energy sector.

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II. APPENDICES

Annex 1: Costs and Conversion Factor Calorific values (Energy contents) of various fuels

Fuel type	unit	Energy content (MJ/unit)	Average price in ETB	Constants to convert expenditure into gross energy content(MJ)	Fuel efficiency ratio	Constants to convert expenditure into useful energy content(MJ)
Fuel wood	kg	15.07	2.60	5.73	0.10	0.573
Charcoal	kg	29.73	3.17	9.51	0.20	1.902
Dung cake	kg	14.50	none	14.50	0.12	1.74
Sawdust	kg	16.75	5.00	3.35	0.16	0.536
Kerosene	lt	33.62	15.00	2.35	0.50	1.175
Biogas	Cu.m	22.80	none	22.80	0.55	11.40
Electricity	kWh	3.60	0.39	(Exp –1.34)(9.22)	0.75	(Exp – 1.34)(6.915)
Candle	piece	1.88	3.00	0.62	0.65	0.403
Dry cell	piece	0.01	5.00	0.002	0.75	0.0014

Source: Source : UNDP , 2007 &MoWE, 2011

Annex 2 : Varying Rates of payment for electricity consumed

Slabs of electricity consumed (kWh)	0 - 50	51- 100	101 - 200	2001 - 300	301 - 400	401 - 50	501 & above
Range of payment (in ETB)	0 -13.50	13.51 - 36.00	36.01 - 100	100.01 - 165	165.01 - 28.00	28.01 - 295.00	295.01 & above
Rate of payment (ETB/kwh)	0.2730	0.3564	0.4993	0.5500	0.5666	0.5880	0.6943

Source: Ethiopian Electric Utility, Arba-Minch Branch,2014

Annex 3: Range of payment for electric meter

Meter rent in ETB	Household involved	Total rent in ETB
1	435	435
2	222	444
4	one free	0
Total	658	879

Ethiopian Electric Utility, Arba-Minch Branch,2014

Annex 4. Households use of a mix of two fuels for cooking purposes

Cooking energy use	Households involved
wood and charcoal	436
wood and dung	84
wood and sawdust	33
wood and kerosene	99
wood and electricity	25
wood and biogas	17
charcoal and dung	59
charcoal and sawdust	32
charcoal and kerosene	123
charcoal and electricity	170
dung and kerosene	13
dung and biogas	17
kerosene and electricity	55

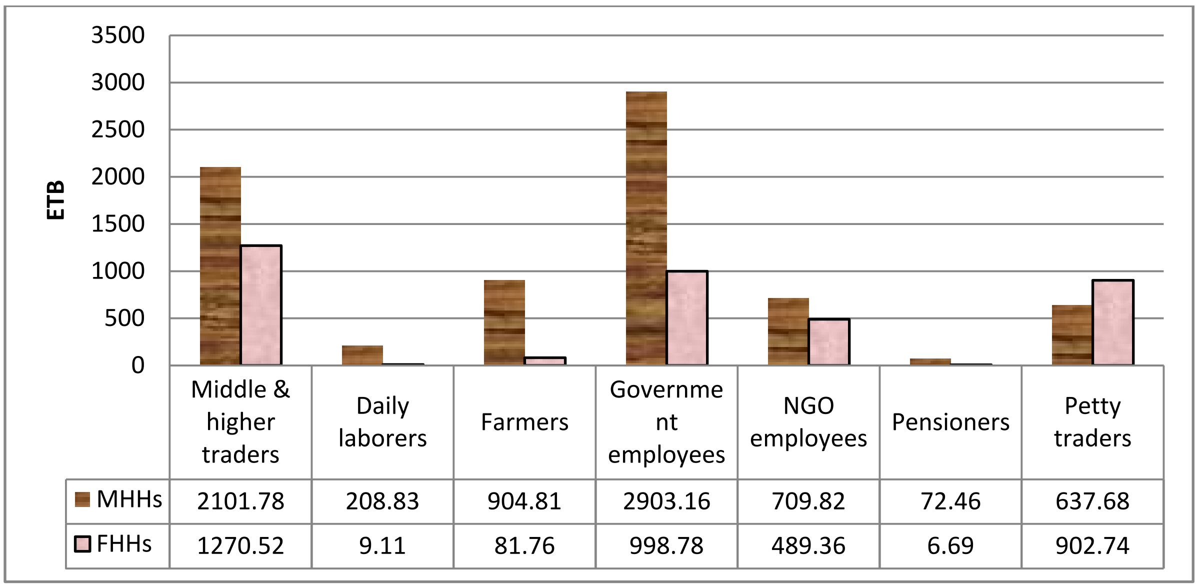
Source: Field survey, 2014

Annex 5 Number of light bulbs used among households

Number of light bulbs	1	2	3	4	5	total
Household involved	6	176	314	157	5	658
%	0.9	26.7	47.7	23.9	0.8	100.00

Source: Field survey, 2014

Annex 6. Mean annual per capita income (ETB) by gender and occupation



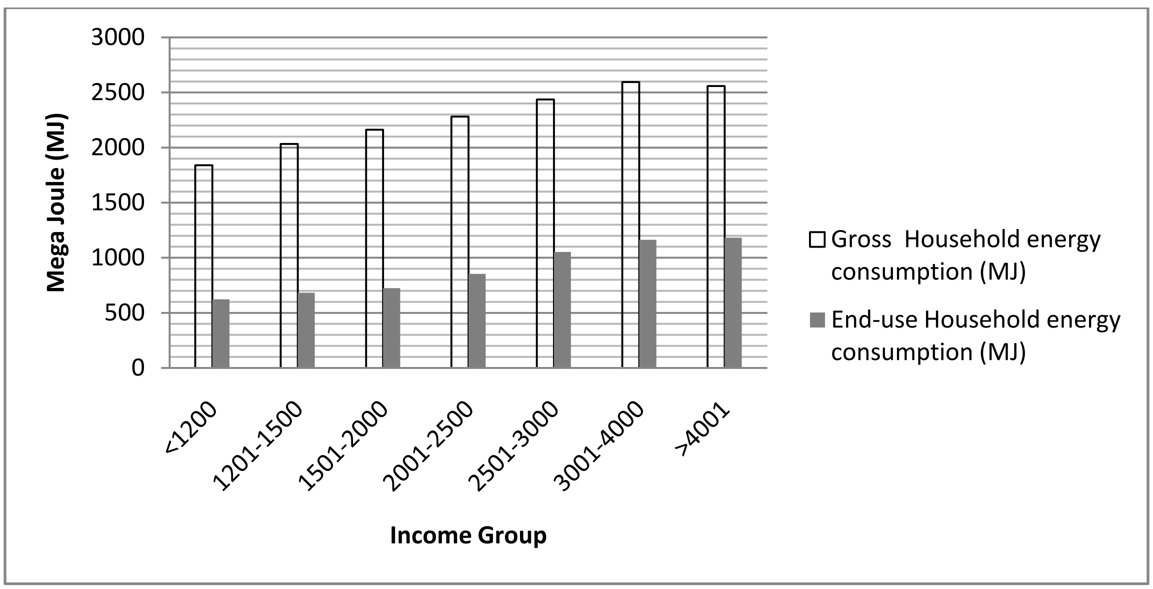
Source: Field Survey, 2014

Annex 7. Share of average gross and end-use energy consumption by gender (in MJ)

Consumption type	MHHs			FHHs		
	Biomass	Conventional	Total	Biomass	Conventional	Total
Gross Energy	1339.14	891.48	2230.61	1398.93	882.76	2281.7
End-use Energy	220.91	660.48	881.39	227.97	652.49	880.46

Source: Field survey, 2014

Annex 8. Gross and End-use Household energy consumption by income group (MJ)



Source: Field Survey, 2014

Annex 9. Share of end-use energy consumption out of the total gross energy consumption (in %) by income class

Fuel type	**Low Income Households**	**Medium Income Households**	**High Income Households**
Biomass fuels	15.66%	16.83%	18.03%
Conventional fuels	74.03%	73.95%	74.16%
Total	33.68%	41.48%	47.64%

Source: Field survey, 2014

Annex 10 Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.891[a]	.794	.790	145.88619

Annex 11. ANOVA table

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	52799064.420	15	3519937.628	165.389	.000[b]
1	Residual	13663544.904	642	21282.780		
	Total	66462609.323	657			

a. Dependent Variable: end-use energy consumption